
A Framework for the Creation and Management of National Computing Strategies in Developing Countries

A. El Sayed Noor

Computers and Information Systems, Faculty of Commerce, Economics and Political Science, Kuwait University, P.O. Box 5486, Kuwait

Experience and observation of computing in many developing countries indicate clearly the need to develop and implement a framework that is conducive to change for more effective computing practices, policies, uses and applications. On the basis of such experience as well as the comparative evaluation of the status of computing in developing countries, this paper suggests a framework for the promotion of effective computing policies, practices, procedures, uses and applications in developing countries. Such a framework characterizes the *main features of an overall strategy that should be helpful in narrowing the gap between developed and developing countries on the effective use of limited computing resources*. Furthermore, the conditions and requirements necessary for the framework to work are explained. Careful examination of the approach appears to indicate that the suggested framework is practicable, flexible, maintainable and easy to absorb and implement.

INTRODUCTION

One striking observation on computing in developing countries is that it combines some of the major problems associated with computing in developed countries as well as the development problems experienced by developing countries themselves.^{1,2}

This exacerbates developing countries' difficulties in achieving the full potential of applying computing knowledge to the benefit of social, economic and political development. Unless such problem areas are subjected to careful examination, they will continue to hinder the progress of developing countries on the computing front.

Furthermore, it is frequently easy to see that developing countries experience the hindrance of diagnosing problems incorrectly. This is one of the serious constraints to progress in developing countries; such constraints have varied manifestations. It is not uncommon in computer education in a developing country, for example, to see that a great deal of effort is devoted to teaching a particular higher-level programming language, or a specific subject area, as if the sole objective of computer education was to produce programmers skilled in that specific language. Very little attention is devoted to the examination of the *overall strategy* that should be followed to narrow the gap between advanced and less advanced countries. In the absence of a carefully planned effective computing strategy for the developing country concerned, it is difficult to foresee any substantial change in the weak position of developing countries. The existence of a carefully planned effective computing strategy for a developing country is a key variable that affects the degree of success in the transfer of appropriate computing technology.

Countries with mature organizations for strategic planning, management planning and operational control are likely to have more effective computing practices, uses and applications than countries not implementing such a planning and control framework.

Discussion in this paper proceeds as follows: first, the researcher indicates the extent to which developing countries could bridge the current gap between developed and developing countries. Secondly, he outlines a suggested framework for the creation and management of national computing strategies in developing countries. A fundamental objective of the suggested framework is to promote the effective and productive use of limited computing resources. Thirdly, the rationale for such a framework is presented indicating the structural theory and empirical support upon which the suggested framework is based. Fourthly, the researcher specifies the way in which the suggested framework could be operated. Finally, a summary of the main conclusions is presented.

CAN DEVELOPING COUNTRIES BRIDGE THE GAP?

Clearly, the answer to such a difficult question depends on the quality of effort devoted to tackling the complex task and the associated challenging problems of improving the current state of computing in the developing country concerned. Specifically, this would depend on a number of vital considerations:

1. Recognition on the part of that country that there is a problem that needs to be addressed seriously. If the problem is not given sufficient attention, it is highly likely that efforts of various organizations and interested individuals would be fragmented and fall short of any reasonable expectations of effective exploitation of computing for social, political and economic development.
2. Organization of the national effort to address the recognized problem in a way that makes clear the responsibilities and duties of groups, functions, individuals and sectors within the economy, regarding mobilization of the necessary resources to improve

use and exploitation for the achievement of national goals and objectives.

3. Formation of a computing policy and strategy based on effective focusing on a realistic set of priorities. Wild ambitions and unrealistic goals and objectives in developing countries are not in any way helpful to improving their computing position. An important requirement is the establishment of specific, detailed and measurable targets to be achieved within a specified time frame. It is a mistake to assume that computing in developing countries would improve merely by following the path adopted by developed countries. The former could learn from the problems and mistakes of the latter to a certain extent. Only by cohesive action and an implementation plan, can developing countries minimize the magnitude and complexity of the problems they face. Only determined developing countries can benefit from the implications of current and future developments in computing and information technologies.
4. The management of the transformation process in a way that is responsive to, and compatible with, demands and requirements of the rapidly changing computing environment. Probably this is one of the most critical constraints on computing in developing countries. Management of national computing strategies, in many instances, does not have the ability or the authority to carry out important and far-reaching decisions to improve the computing position of the country concerned.
5. The on-going review and evaluation of experience, progress, problems, obstacles and possible solutions. Accountability and performance measurement against specific and detailed targets is vital for any progress to be achieved on a long-term basis.

A FRAMEWORK FOR THE CREATION AND MANAGEMENT OF NATIONAL COMPUTING STRATEGIES IN DEVELOPING COUNTRIES

The message emanating from the above analysis indicates the necessity of looking at non-conventional approaches

in order to narrow the gap between developed and developing economies. A necessary prerequisite is recognition by the country concerned of the importance of a carefully planned and implemented structure for directing national computing strategies for more effective use, application of computing resources and approaches for development. Such recognition has to be within an overall framework co-ordinating development programmes between different areas of national computing activities.

In this respect, this researcher suggests the following framework in which three types of organization play an important role. These are:

- (a) Computing Council (or Board)
- (b) Schools of computing sciences
- (c) National computing centres

These organizations are seen to be the pillars of a structure for directing an overall computing strategy in developing countries. If carefully planned and implemented, they should contribute to more effective application and use of computing resources.

Figure 1 is a simple schematic model of the relationships between the three proposed organizations.

(a) Nature and objectives of a Computing Council or Board

Basically a Computing Council addresses critical matters of national importance in the related fields of computing in general. Supported by in-depth task force studies, such a council should lay a firm foundation for the development and growth in computing knowledge and experience. This body should also establish the foundation for high standards in skill and knowledge in computing. Meanwhile, such a council should establish ways and means of disseminating knowledge related to developments in the computing field. Some examples of activities of the proposed Computing Council might be:

- (i) Establishing national computing goals.
- (ii) Formulating national computing policies in co-ordination with policies in other related fields.
- (iii) Ordering priorities.

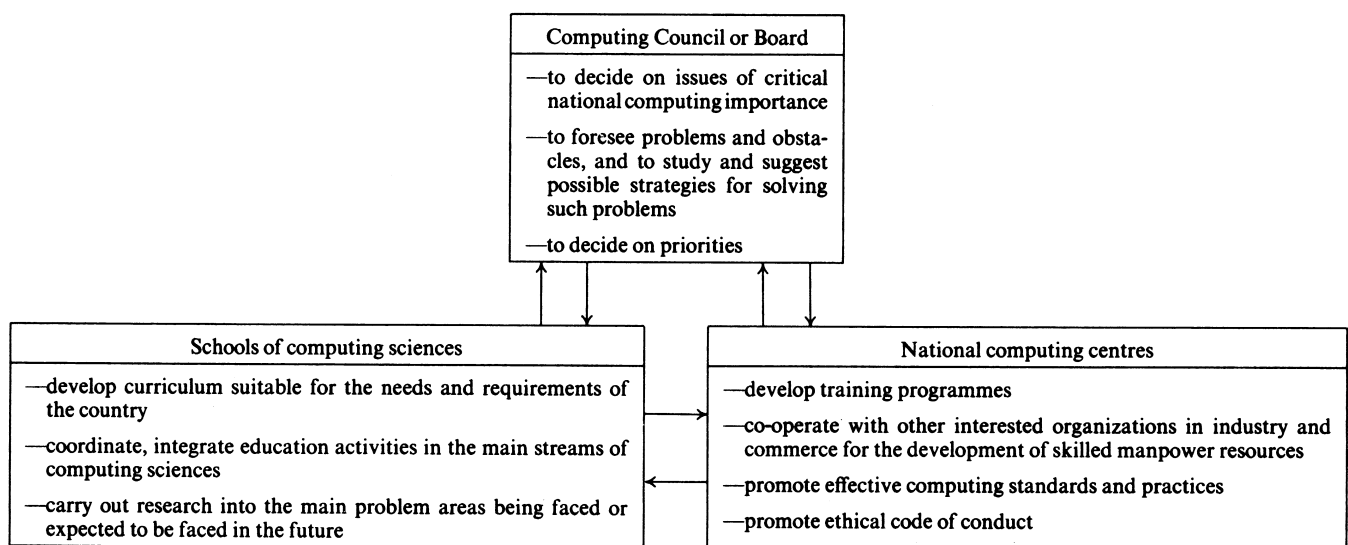


Figure 1. A schematic model of the three proposed organizations responsible for the creation and management of national computing strategy in developing countries.

- (iv) Designing strategies for computing sciences education after a careful examination of alternatives.
- (v) Reviewing the computing needs of schools of computing sciences in universities and academic institutes in the light of their objectives, needs, and requirements.
- (vi) Devising ways and means to encourage co-operation between schools of computing sciences and national computing centres on the one hand, and organizations in industry, business and commerce on the other.
- (vii) Sponsoring detailed and comprehensive studies to plan future directions for computing; particularly in relation to major controversial issues such as charging out for computer services, the introduction, development and selection of data bases; the appropriate forms of data communications and networking and the application of microprocessors.

(b) Schools of computing sciences

On the education front, as a basic national priority for the supply of skilled computing manpower in developing countries, the concept of 'schools of computing sciences' might be useful for developing countries in the long-run. Such schools, if accepted, would be organized on lines similar to medical, law and engineering schools, in the sense that computing sciences schools would be regarded as a reasonably autonomous administrative organization within a university. Such schools should provide education for careers in the three major streams of computing sciences:

- (i) computer engineering
- (ii) informatics or computer science
- (iii) computer-based management orientated information systems.

It should be emphasized, however, that *implementation of such a concept might take different forms of organization. What matters is the notion rather than a specific form.* Meanwhile, the notion of reasonably autonomous schools for computing sciences certainly has its advantages and its disadvantages. The advantages for developing countries outweigh the disadvantages in a number of ways; chief among them are:

1. Developing countries have, in general, very limited computing resources (human and otherwise). The concept of a computing sciences school might allow the limited but necessary resources to be pulled together.
2. The concept of a school might help co-ordination and integration. Such a school would be the focal point for the study of the three major streams of computing sciences.
3. Developing countries need a 'big push' to be able to absorb such rapidly changing knowledge; concentration of effort in one school might be helpful.

It is possible, however, to suggest major aims of the schools of computing sciences:

1. To promote computing sciences knowledge and experience in the best interests of the country.
2. To pursue the study of computing sciences and their applications in a co-ordinated and integrated manner

with particular emphasis on national needs; the study should cover the three main streams of computing sciences

- (i) computer engineering (electrical and electronic)^{3,4}
- (ii) theoretical and experimental computing (informatics or computer science)^{5,6}
- (iii) computer-based management orientated information system.⁷⁻²²

The form, organization and implementation of the study programme would be on lines similar to those followed by schools of medicine, law and engineering.

3. To carry out research in the various sectors of computing sciences.
4. To address problems emanating from, or associated with computing for development.
5. To exchange information, lectures and education programmes with organizations and institutions having similar interests.

(c) National computing centres

National computing centres are the third element in the proposed strategy—though by no means less important than the other two. The NCC has a major role to play in the proposed strategy, but to expect that it would be responsible for everything concerned with national computing progress and advancement would be unrealistic. *Within the suggested framework the NCC would not assume the monopolistic position frequently observed in some Arab countries. The NCC would seek to implement strategies laid down by the Computing Council, mainly in the areas of technology transfer, training, standards and the promotion of more effective policies, practices and uses. To rely on the NCC for longer-term effective computing in a developing country would put the legislative and executive powers in the one hand. Under the proposed framework, concepts such as strategy, control, accountability, management planning control measures, efficiency, and effectiveness would have much more meaning and significance than the single organization system.*

Within the proposed framework, the following are some suggested aims of a national computing centre:

1. To develop educational and training programmes for computer specialists, i.e. programmers, system analysts, operators and other related staff functions.
2. To train and develop computing instructors on an ongoing basis in order to make up the serious shortage that exists now.
3. To develop educational and training programmes for computer users to instil more awareness of what computers can and cannot do for them.
4. To offer consultancy services on matters and problems of concern to organizations using or intending to use computer resources.
5. To promote awareness of recent advances and future directions in information technology and applications; this is vital for organizations employing computer resources, since keeping abreast of the latest technology and application is by no means an easy task.
6. To encourage the use of effective computing standards and practices.

7. To co-operate with other interested organizations in the development and maintenance of a professional code of conduct.

THE RATIONALE: STRUCTURAL THEORY AND EMPIRICAL SUPPORT

Quite rightly, the reader may question this strategy by posing a number of questions, including:

1. How important is the proposed strategy to the improvement of the practice of computing in developing countries?
2. Does the framework provide insights into the current status and future directions of computing for development?
3. Does it contain some elements that are likely to be helpful for planners and others interested in the effective use and application of computing technology and knowledge to development?
4. What are the strengths and weaknesses of the suggested strategy?

Clearly, the extent of usefulness and importance to a particular country depends on the stage of computing development and use in that country. Some countries have made considerable progress on the computing front, others are still lagging behind. However, the suggested strategy is based on broadly applicable observations that are likely to be of more interest to those economies at an early stage of computing development.

First. The suggested framework has its roots in the principles, procedures and practices of management control systems where a distinction between strategic and tactical dimensions is made.

Countries with mature organizations for strategic planning, management planning and operational control are likely to have a more effective computing structure, use and application than countries not implementing such a planning and control framework.

The phrase 'more effective' is not meant to be a descriptive or general one. It is a quantitative measure and indicator of the status of computing in a given country. It specifically means:

- (a) advanced application and use of computers
- (b) high number of skilled personnel
- (c) high number of software systems developed and implemented.
- (d) large number of educational programmes in computing and information systems—at both the undergraduate and the graduate levels.

Comparative analysis between advanced economies and developing countries would support such a thesis. Practical experience of the USA, UK, Japan, France and West Germany on the one hand, and Arab countries on the other would corroborate the above reasoning. Even between developing countries themselves one can easily observe significant differences, as in the case of Mexico, Brazil, Hong Kong, Singapore on the one hand and many Arab developing countries on the other.

Second. The suggested framework could be a way of implementing and operating the frequently emphasized issue of 'national informatics strategy and policies'. The experience of several Arab countries—e.g. Egypt, Iraq, Kuwait and Saudi Arabia—demonstrates clearly that the

concept of 'national computing centre(s)' as the sole guardian for computing technology transfer has its limitation. More effective computing policies, procedures, programmes and approaches could be designed and implemented if there were other bodies and organizations similar to those suggested in the proposed framework. The absence of a body having similar functions such as those outlined under the Computing Council leaves much to be desired.

The experience of other developing countries such as India and Singapore demonstrates clearly the importance of having an integrated approach to computing technology transfer. The Indian Electronics Commission is a case in point. The experience of south-east Asian countries is of particular relevance and significance in this regard.²³⁻²⁷

It is no exaggeration to indicate that organization of computing technology transfer is one of the most critical variables facing developing countries.

Third. The suggested framework should contribute to satisfying the following needs of developing countries:

- (a) The need systematically to study problems and opportunities of computing technology and knowledge with particular emphasis on the needs and resources of the country under consideration. This falls within the domain of the Computing Council, which in this respect, is considered to be the 'think tank' interested in establishing long-term policies, strategies and priorities. Few developing countries have studied options available to them in the areas of microprocessors, data communications, computing manpower, curricula and the like. The suggested Computing Council has a fundamental responsibility in this respect; that is the promotion of knowledge and skill in computing and strengthening the role of computing in the achievement of national goals. It has a basic responsibility of laying the foundations for sharing scarce computing resources among the various sectors of the country. To summarize, the *Computing Council has to guide the direction of the country in advancing its computing infrastructure. It has to identify major national issues, priorities, as well as the careful examination of far-reaching longer-term issues of fundamental nature to the country concerned.* In relation to this, the following are some examples of far-reaching computing issues that need to be high on the list of the Computing Council's list of priorities.
 - (i) The effects of *microelectronics* on industry, commerce, business, education and all other sectors of the economy.
 - (ii) The place of *data communications* and *networking* facilities that best serve the needs and requirements of the country.
 - (iii) *Security, data protection and control* are fundamental issues that need to be studied thoroughly to develop real measures of control regarding accessibility and the use of data in a country where professional standards are less mature than those in the developed economies.
 - (iv) The current and expected use of *databases* and *database management systems* is growing rapidly. A great deal of effort needs to be spent on deciding on the best course of action to be followed by the country concerned.

Longer-term issues of such a fundamental nature need to be studied and decided upon as soon as possible by developing countries.

- (b) The need to pull together badly needed and scarce resources. Co-ordination and collaborative efforts, on the basis of a coherent action programme within an overall strategy, in the areas of education and training, for example, would be more productive in contributing to solving the acute shortage of skilled computing personnel.
- (c) The need to have an industry-orientated organization that has a prime responsibility for the creation of an environment in which training of computing professionals could flourish. Under the proposed strategy the NCC assumes such responsibility in a manner that is different from existing NCCs in Arab developing countries. The role of the NCC should be viewed within the framework outlined above. The NCC should be the 'industry training arm' of the Computing Council. It should implement policies and strategies laid down by that Council.

Fourth. Although many developing countries have created one form or another of a 'Computer Society', such learned or professional societies and associations do not have the necessary powers and resources significantly to change the weak systems infrastructure and computing practices. Some developing countries are led to believe that such computer societies or associations are sufficient to mobilize computing resources and contribute significantly to improving the status of computing there. Accordingly, matters are left as they are in the hope that natural evolution of computing events and practices will eventually improve the effective use of computing resources. This is an ineffective policy that has long-term negative consequences. Therefore, it is important to recognize the implications of such limited contribution on the part of professional societies or associations, at least in the foreseeable future.

Fifth. At present, governments often pay only lip service to the importance of computing for national development. The proposed framework will underline the need for serious government support and backing for national computing development. Under this framework, the government of the country is required to do more in the form of budgets, detailed targets, necessary funds, performance measurement and accountability control. Advancing the status of computing practices in a developing country can only be achieved in a structured and coherent overall strategy backed by government support and accountability. Experience indicates that the NCC cannot alone carry out such responsibilities. Furthermore, without sufficient government backing, support, co-ordination, and planning on the basis of reliable manpower studies, it would be difficult for universities and academic institutions to meet the real needs for skilled computing manpower. This highlights the importance of the role played by the Computing Council under the proposed strategy.

Sixth. Training and education are fundamental components of the suggested strategy. They are the main source of long-term supply of skilled manpower in computer sciences for the country concerned. This explains why the proposed strategy is suggesting making full use of both the NCC and the schools of computing sciences.

NCC's have been set up in many developing countries, mainly for training purposes. Some of these may not be as effective as their counterparts in developed countries, but it should be the responsibility of the Computer Council or Board to review and assess the NCC performance in the light of specific and detailed targets as outlined in previously approved plans. Accountability and control are essential ingredients in the mechanism of the suggested framework. The significance of this argument becomes clear when one attempts to review the structure and performance of NCCs in different developing countries. Unless the performance of such organizations is measured against specific and detailed targets and objects, it is hard to see how accountability and control can take place.

Computing sciences education, according to the suggested framework, is the responsibility of schools of computing sciences. Such schools could be the means of focusing attention on computing sciences education and research. Given the proper environment, schools of computing sciences could contribute to the longer-term needs of skilled computer educators and professionals. The idea of integrated, autonomous schools might be more effective in *co-ordinating the frequently fragmented efforts in universities in developing countries*. Such an approach might be more helpful in responding to rapid technological change and the accelerating rate of development. It is important to remember that the state of computing education and practice in developing countries is different from that of developed countries. Universities in developed countries, such as the USA and the UK, have created a strong base for education and research in the main streams of computing sciences. The on-going discussion, seminars and conferences are but a few examples of the ways in which further advances are made. In summary, developing countries simply lack such a healthy environment. The evolutionary path followed by universities and academic institutions in developed countries might not be the best way to achieve national computing needs of developing countries.

In view of the above discussion the proposed Computing Council or Board is expected to, and should, play a significant role in stimulating educational, research, and training programmes within the framework of an overall computing strategy. On the basis of plans, budgets, grants, specific and detailed targets, reviews and accountability, measurement of a developing country's progress on the computing front could be made.

IMPLEMENTATION OF THE SUGGESTED FRAMEWORK—THE CHALLENGING AND COMPLEX WAY AHEAD

Transforming the above proposition into a workable framework and practical reality in a developing country requires more than goodwill. It is a mistake to assume that following a natural evolution of activities, as did developed countries, would lead a developing country to mature and effective computing. Such maturity takes a long time to achieve and requires considerable investment in planning, time, human and other resources. This is a complex and difficult area. Developed countries, themselves, are trying to keep up with present and prospective technological advances as well as meeting the growing

and ever-increasing demands for more efficient and productive uses of computing and information technology in new areas.

Prerequisites

The strategy have been outlined, but before operation of the proposed framework is described, a warning is necessary.

It would be an oversimplification to assume that the proposed framework would overcome the rooted problems of developing countries. *The model suggested is considered by the researcher as a starting point in a phased implementation plan.* Unless it is followed by a periodic review of progress, lessons, problems and obstacles, this framework would have very little value. For developing countries, the way ahead is full of obstacles and difficulties but the initiative to any real progress on computing for development has to come from the country itself. This is an example of the many aspects that developing countries should be aware of when building up their computing infrastructure. Further points to keep in mind in relation to computing for development follow:

1. Bearing in mind the present trends in computing technology and applications, computers have a significant role to play in social, economic, and political development.²⁸⁻³² (One cannot help feeling that in developing countries, government departments responsible for the formation of computer policy, attach more importance to what might be called the 'celebratory' attitude towards computers. Computers, as far as they are concerned, are signs of progress; having the biggest and the most advanced machine is an important item to include in their reports; apparently without much attention to what might come out of such use of the latest technology. Assuming, of course, that those government departments could afford the resources that should be committed in that direction.)
2. The initiative to any real progress in computing for development has to come from the developing country concerned. International organizations, and developed countries might show some interest in that direction, but the onus is on the developing country concerned to start building up its computing infrastructure. Given the best intentions on the part of the international organizations and developed countries, no real or significant change will be achieved unless the developing country under consideration commits resources to developing its computing and systems infrastructure. Any assistance from developed countries could then be channelled in the most effective manner.
3. Strategic planning, budgeting and control measures are fundamental mechanisms whereby every developing country should develop its computing knowledge and experience.
4. As there is a considerable interdependence between the use and advancement of computing applications on the one hand, and the maturity of administrative and management structures on the other, a wide-ranging review of such management procedures, principles and practices needs to be made to enable real computing progress to take place.

Operation of the proposed framework

To operate this framework, the researcher suggests the following specific steps:

- (a) *Create the environment in which the desired change could take place.* Upon recognition of the problem, serious commitment should be made on the part of the developing country concerned to pave the way for major changes in the structure and practice of computing. As indicated in the suggested framework, a Computing Council or Board is required to direct the changes desired. It is vital that such a council be selected and formed in a way that would make it possible to promote change for more effective computing practices, uses and applications. The suggested council should not be a duplicate of NCC responsibilities and activities. As already shown, the council should guide the direction of the developing country in advancing its computing infrastructure.

Among the immediate difficulties facing the suggested strategy and the Computing Council or Board is the selection of a *Managing Director* as well as the most effective organizational form within which a programme or action plan for computing improvement could take place. In this regard, the Computing Council or Board should be aware of the need for the following conditions:

- (i) protection against bureaucracy (it is essential to have a dynamic management structure)
- (ii) ensuring sufficient resources
- (iii) keeping within development boundaries (wild ambitions and unrealistic objectives should be avoided)
- (iv) collaboration between different parties and sectors within the computing community
- (v) government backing and support to stimulate effective and productive computing for the achievement of national goals and objectives
- (vi) computing knowledge dissemination and communication as well as understanding of the role and implications of computing for development
- (vii) motivation and the need to reverse the 'brain drain' problem.

It goes without saying that the catalyst to the whole process is the gap between the desired and actual computing practices in the country. Therefore, it is essential that conditions for success be ensured.

- (b) *Diagnose the current stage of computing practices.* The idea is to arrive at a detailed picture of the country's state of computing development. The result of such an analysis should give an accurate measure of the strengths, weaknesses, and requirements of the current state of computing development. Among the major areas of concern in this respect are:
 - (i) computing manpower supply and demand
 - (ii) users; their profiles and characteristics
 - (iii) applications orientation
 - (iv) database evolution
 - (v) hardware/software environments
 - (vi) computer education and training resources, opportunities, adequacy and effectiveness
 - (vii) practices, policies
 - (viii) problem areas

- (ix) strengths and weaknesses
- (x) efficiency and effectiveness in the achievement of national goals and objectives.

As a background to such an analysis, there should be a clear indication of the state-of-the-art in computing. This should be helpful in establishing priorities, detailed specific targets, what could—and could not—be achieved.

It is important to reiterate that, without a high degree of technical computing knowledge on the part of the management team (i.e. the change agents) implementing the strategy of the Computing Council, it is difficult to foresee any significant progress in relation to improving computing practices and effectiveness. If this step is carried out seriously, it would significantly contribute to a clearer understanding of weaknesses and strengths of computing practices.

- (c) *Design a programme for improving the current state of computing.* Having clearly identified the current strengths, weaknesses and state of computing practices in the light of present and prospective computing development in general, a programme should be designed to transform the computing structure and practice. The corner-stone of the programme is a set of detailed, measurable, and specific targets to be achieved within a clearly defined time horizon. Such targets should take into consideration priorities, and available resources.

Implementation of the programme would make full use of activities and resources at schools of computing sciences and the NCC as well as other organizations in the country.

For developing countries, education and training is a major source of long-term supply of skilled human resources. The place of education and training in the proposed strategy and its implementation is crucial and fundamental. This clearly explains why developing countries—seeking to improve computing policies and practices—are in urgent need of restructuring their sector and organizations. It points out the importance of the role of schools of computing sciences and the NCC in the suggested framework. Investing sufficiently in the areas of education and training in computing is an important consideration.

- (d) *Establish a mechanism for on-going review of performance against targets.* Detailed and comprehensive reviews of objectives, targets, limitations and shortcomings on a regular basis is an important consideration. The Computing Council should make full use of resources available at schools of computing sciences, the NCC and other knowledgeable parties and organizations.

On the basis of constructive evaluation of the

degree of progress achieved, the Computing Council could revise targets, mobilize resources, initiate projects, and prepare action plans for the continued improvement of computing practices.

The wealth of computing experience gained by developed countries should be very helpful to developing countries in restructuring the organization and management of computing development programmes. What developing countries should avoid is duplicating what developed countries have done without giving due attention to the different conditions and circumstances of the concerned developing country.^{4, 10–13, 21, 33, 34} Adapting what is currently available to fit the particular needs, requirements and objectives of that country is an important consideration towards improving productivity of the computing sector. The suggested framework could serve as a means of rethinking the organization and management of overall national computing strategies in developing countries for the promotion of more effective and productive computing practices and use of resources.

SUMMARY

Although computing advances in developed countries continue to grow in almost every direction, developing countries, in general, experience a host of difficulties and dilemmas in relation to the effective use of computing for development.

This paper is mainly concerned with the promotion of computing knowledge, experience and effective use of computer resources in developing countries. In the absence of a carefully drawn strategy for the creation, direction, and management of national computing policies and practices, real progress could not be achieved.

On the basis of this assumption, this paper outlines a triangular strategy for computing in developing countries. At the peak of the triangle is the Computing Council which should assume a strategic role in the national improvement of computing resources and their use. Schools of computing sciences and the national computing centre are the two major pillars upon which implementation of strategies would take place. Schools of computing sciences, on the one hand, should create a healthier environment for computing education and research in an integrated and co-ordinated manner. Such implementation of strategic policies should be on the basis of priorities and resources allocated by the Computing Council. The National computing centre, on the other hand, should strengthen the computing contribution to the government, business and industrial sectors of the economy and to society. Then, and only then, could a significant contribution and real progress be claimed on the effective use and application of computing resources.

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