J.King Saud Univ., Vol.8, *Computer & Information Sci.*, pp. 57-77 (A.H 1416/1996)

Information Technologies in a R&D Environment

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(Received, 11 Sept. 1994; accepted for publication, 20 Feb. 1995)

Abstract. The impact of information technology (IT) on research and development (R&D) activities as well as on researchers and scientists are discussed in this paper. The lack of data related to the influence of modern IT on scientists and engineering researchers is highlighted. This issue is viewed on the basis of the generic characteristics of the relationship between IT and scientific research. The present day understanding of this relationship is reviewed by considering the role of calculations in R&D and its places regarding research productivity. Light is also shed on the interaction between research practice and IT from two angles. First, the business side of managing an R&D institution is considered and secondly, the aspects relating to the behaviour of researchers and research groups is discussed. IT's impact on R&D institutions in a developing environment is addressed further with emphasis on the most striking factors differentiating it from a developed environment. Some specific features related to information centre/user's relationship in developing countries is also discussed. The overall scene in the developing Arab information arena could be summed up as one in which there is a reasonable level of scientific and technological information resources. This is not matched by an equal level of user's appreciation of the role of IT in the enhancement of R&D.

1. Introduction

Many developing countries have established R&D institutions during the past three decades, with the primary purpose of supporting the development of the country in ma-

many key areas. Most of these research and development institutions were established on the lines of institutions existing in industrial countries and were often set up as national government research organizations with a wide sectorial coverage. Years later, many of these R&D institutions are facing problems due to improper alignment of their objectives and sectorial needs, added with shrinking government support, financial or otherwise. Their capabilities and organizational characteristics are increasingly out of step with the requirements of new situations faced by their countries in the 1990's, principally, the strong pace of technological advance as a result of new technologies. Never-the-less, developing countries have built up significant scientific and technological capabilities in R&D institutions and have invested heavily in this infrastructure. They have built up cadre of well-trained scientists and technicians. The main characteristics of R&D institutions are:

* Organizational structures built around research programs emphasizing type matrix structure while executing research projects.

* Management functions such as planning, budgeting are done with will defined management procedures that are adopted to suit local conditions of business environment.

* R&D activities cover basic, applied (client funded) and performing technical services.

* R&D output comes in a variety of forms, such as:

-- Reports containing findings (numerical models, etc.) or baseline data.

-- Information mapped on graphs or maps.

-- All kinds of computer related information based systems.

The rate of innovation in the world has accelerated dramatically in the past ten years, particularly, in the new technologies of microelectronics, biotechnology, new materials and others. This follows scientific advances in solid state phases, genetic engineering, computer sciences and other disciplines where dynamic work is being conducted. There has also been dramatic improvement in scientific test equipment and analytical techniques. These new technologies have often a "generic" nature that makes them applicable to different sectors and activities. Here, the prime example is information technology, which finds wide use in industrial sectors, telecommunications and service activities, and is transforming the work place and the way people work.

The lack of empirical research concerned with how information technology affects scientific research and development is highly felt in the scientific community. This scarcity of data stands in sharp contrast to almost all other work place settings in which computers are found. There is considerable research literature on how IT affects clerical staff and managers as individuals, and manufacturing and service industries as organizations.

The reason for this shortage of research on scientists and engineers may stem from an implicit -- and incorrect -- assumption that social scientists have made about IT as innovation. It is obvious that widespread use of distributed processing is an innovation in most business and government settings. Relative to R&D, however, social researchers may have held the view that researchers have always used computers, and now they are just using more computers. It should be emphasized in relation to this possible point of view that modern IT represents a profound change in the techniques and choices available to all those within an R&D environment.

Information technologies are those microelectronics technologies that have revolutionized the way information is collected, analyzed or processed, transported and stored. This means that information systems can be built, to deal with huge volume, high rate and diverse sources of information all integrated in a manner that provides valuable support for the decision making process. This in turn, will result in a positive impact on individual corporate performance. The introduction of IT in any organization basically influences its performance in two areas; enhancing internal procedures by automation through computerization and consolidating the interface with the outside world through better output that meets the need in a manner that gives maximum understanding. Depending on the relationship of the internal organizational structure and external relations, the core of reform and needed changes is determined.

1.1. Introducing IT to The Organization

IT introduction can be achieved in an organized structured way through a plan formulated and administered by top management or left for the needs and opportunities as they arise in specific areas. In order to maximize the benefits of using IT, work activities have to reach some level of automation. The overall objective of the IT plan is to structure the activities of the enterprise so as to fully adopt, modify and utilize IT effectively. A basic, generic IT plan model has been formulated based on literature and experience. It consists of four major generic activities: strategic corporate plan, information requirement analysis, resources allocation and implementation schedule.

Every corporate strategic plan calls for step-by-step adaptation and utilization of IT. The problem faced is how to align and restructure organizational objectives so as to make the most benefit from the introduction of IT. For this end, the organization must

re-examine and re-assess organizational objectives and strategy together with a thorough assessment of the organizational environment (hardware infrastructure). The output of such exercise will be an accurate perception of the strategic aspirations and directions of the organization. The organizational information requirement's analysis commences by first assessing current status and projected information needs that will support operations and decision making. An information system architecture (databases, etc.) can thus be developed giving emphasis to long range needs as well as meeting short range information demands. Defining accurately, information requirements, is a difficult task to achieve due to lack of/or incomplete information. Besides, there is no well defined methodology or process for information requirement's determination. Since many of the information requirement needs as provided by humans, a source of error is introduced. Therefore, the set of information requirements reached may most probably be incomplete.

Resource allocations consist of mainly developing procurement of human and infrastructure resources. Human resources development (HRD) is given high priority as it constitutes high investment with return. HRD includes staffing of experienced IT personnel and the continuous training of the current work force. Development of resource facilities such as completion of network infrastructure is also considered essential so as to be able to utilize the full spectrum of IT capabilities.

The above three activities are to be implement and completed according to a devised plan showing start and completion dates of various activities as well as cost. Room is also to be allowed for implementing essential changes after proper reviews.

1.2. IT Support for Research Output Activities

Research output depending on the problem tackled, takes various forms such as technical reports containing qualitative and quantitative descriptions and solutions of typical infrastructure development problems, computerized databases and electronic application systems in various fields such as industry and commerce. IT has been very influential for its support in all dimensions whether it be on the data collection side or its analysis and presentation side. IT has provided researchers with new and added tools to study new types of problems, correlated various kinds of data forms, to function more independently and in a more efficient manner.

1.3. IT Support of Internal Working Procedures

IT support for the internal making procedures will become most effective only when implementation is applied incremental wise. The main advantage of IT support has been its adaptability and conformability to the ever changing internal working procedures. Typical examples of IT support include: computerized personnel databases,

financial packages support systems, project formulation and approval cycles. All kinds of databases that support the intercommunication activities between the various departments of an institution can be put on-line for all user's to access freely and with up-to-date information.

1.4. IT Characteristics

IT as a force for technological change has certain main characteristics that sometimes show a similar path of evaluation like other technologies such as the creation of new opportunities ... etc. But several distinguishing characteristics draw clear distinction between IT technology and other technologies that we are accustomed to. Examples of such characteristics include the dramatic fast pace of development and the social disruption of the work force resulting in the placement of obstacles for its introduction due to misjudgement of IT results interpretation by those directly affected. As IT advances, so is the increase of so called "Computer related crimes," and this has brought up many issues such as "privacy" and information security [1].

1.5. IT Campaign of Promotion

Western world developers of IT have devised specific plans for IT introduction at two main points: The industrial establishments and the public. At the industrial establishment front, emphasis were made towards: (a) industrialization of information, i.e., establishment and fostering of information industry, and (b) management of industries, entities, i.e., utilization of information technologies for better management, thus yielding more through put. At the public front emphasis were made towards the establishment of information oriented societies and the paperless world. In this paper, we shall start by identifying a framework for the impact of IT on science and engineering research work. This will be followed by considering the specific cases of developing countries where IT's influence on a typically representative R&D environment will be discussed

2. Relationship of IT to Scientific Research

Four basic changes in computer technology are affecting scientific research. The first is the development of ever larger super-computers that allow researchers to reach unprecedented frontiers of calculation. Second, on-line databases and electronic communication are giving researchers fast access-to ever growing sources of information. Third, computer technology is giving researchers new ways to collect, manage and analyze data. Finally, researchers are gaining every more personal control over continually growing information processing. These changes point to three general changes in the research enterprise:

* Individual researchers (and research groups) are becoming less reliant on other peoples control of computing facilities

* New types of problems can be addressed

* Results are obtained more quickly

3. Current Status

Despite the lack of empirical data, there are several aspects of the relationship between IT and research practice that are important to the issue.

3.1. The Role of Calculation in R&D

Two broad areas where computers are affecting R&D needs for advanced computational tools can be identified:

* Computers may influence decisions related to what research questions should be addressed, through the supply of radically new methodological choices

* Research policy must be adopted to nurture advances in computing due to the important role the latter pays in furnishing an advantage in scientific and technological leadership.

3.2. Scientific Productivity

Although measuring scientific productivity involves a host of difficult problems, there has been a serious effort to address the issue [2]. The basic problems encompass most of the methodological difficulties in this work. First, the quality of research has proved almost impossible to qualify. Given this lack, any quantitative study of research productivity fails to capture the essence of much true advancement in science.

Second, it has been very difficult to establish casual links between easily quantifiable factors and the R&D outcome. Over and above, the general problems of relating inputs to outputs, there is the complication that input/output relationships may differ across disciplines or fields of study. For instance, the impact of increasing funding, or personnel, or research time in one discipline may not generalize to other fields.

Factors that do have an important impact on research may lie within the social-psychological realm, and thus be difficult to measure across broad, varied contexts.

Examples of such factors include unit director's leadership qualities and research satisfaction with their work.

As far as the impact of IT on research is concerned, there are important considerations that need to be taken into account, namely:

* Efforts to assess the impact of IT on the quality of research are extremely difficult.

* Since the relationship between input and output variable may vary across different scientific disciplines, it becomes important to identify those facts which explain differential effects of IT in particular contexts.

* Because social and psychological factors may have a strong impact on scientific productivity research on the impact of IT should pay careful attention to intra-workgroup relations and dynamics.

3.3. The Nature of Technological and Scientific Action

The important theme that emerges from the above discussion is one of a philosophical nature. As social, disciplinary or organization factors change, so too does the relationship between IT and scientific productivity. Another, contextually different consideration, is the difference between scientific and technological activities. Analysis of these differences reveals how the intended use of information may affect the impact of IT on the course of research. Morell [3], presents a comprehensive review on the philosophical differences between science and technology.

The nature of technology was investigated by many researchers. Wiesner [4, pp.85-94], is of the opinion that: "Technologies achieve their most elegant solutions when an adequate theoretical basis exists for their work but normally are not halted by the lack of a theoretical base. They fill in gaps by drawing on experience, intuition, judgement and experimentally obtained information.' Skolimowski [5], states that the goals of science are to investigate reality, enlarge knowledge, acquire truth and study "what is." In contrast, the goals of technology are to increase the efficiency of given techniques, create a reality of our own design, and to be concerned with what "ought to be."

A fundamental element of scientific research is the development of theory and its testing for accuracy and truth. Further, those in pursuit of truth have no obligation to test theory in real world settings, or to demonstrate practical applications.

Technological action, however, is basically concerned with whether a theory can assist in achieving desired target or not. It does not matter what combinations of casual relationships are encompassed by theory, or even whether the theory is correct. Bunge [6], gives an excellent discussion of this issue.

4. Implications for Information Technology

The above analysis of the nature of scientific and technological work was necessary in as far as it demonstrates what all this implies with respect to IT. One important issue that stands out is that research efforts may differ considerably in the emphasis they place on achieving the greatest possible accuracy of measurement. If research settings can be assessed in terms of the importance of measurement accuracy, it may be possible to predict the direction in which researchers will seek to employ their IT.

A second implication for IT derives from a combination of four related ways in which research efforts may differ for each other:

* Emphasis on achieving a clear difference/contribution to practical settings

* Emphasis on prediction and control

* Combination of scientific and non-scientific information

* Willingness to combine compatible courses of action

Together those factors illustrate the degree of diversity of information that is important in a research environment. IT might be used quite differently when the goal is integration or co-ordination of diverse information, rather than increasing the accuracy of relatively few measures.

4.1. IT Interaction with The R&D Environment

By touching upon the nature of work activities in an R&D environment, we are trying to shed light on the interaction between research practice and IT. Horton's [7] work on Information Resources Management (IRM) exemplifies this approach. In his treatment of IRM in laboratory setting, we can identify two areas where modern IT may affect research. These are:

1- IT can affect the "business" aspects of managing a research institution. This is a traditional information system perspective that tries to manage the data needs of any complex organization.

2- The behaviour of researchers and research groups may also be affected in three areas:

* Special information needs

* Relationships to their laboratories

* Knowledge product, which is the core of their function

The business aspects

The ability to access, manipulate and share information is being profoundly affected by office automation (OA) technology and its organizational concepts, distributed processing, information resources management, etc. These changes can affect research settings in a number of ways. Sharing information among laboratories working on different aspects of a large project, production of traditional management information (e.g., budgeting, procurement, personnel) and relation with the outside environment (government, community, etc.) are the main spheres where OA automation can influence research.

In spite of the scarcity of data on how OA can effect the business aspects of research, it is logical to assume that the effects will be similar to other complex organizations that integrate OA into their operations. In general, we can expect the following:

* Appropriate and efficient use will lead to major increases in organizational rformance. New types of information will be available for decision making. Communication among groups will be facilitated and the quality of written reports and audio visual presentations will improve.

* Office automation will enhance whatever movement the organization chooses in the direction of centralization or decentralization, or relative to other elements of organizational change.

* The distribution of impact will vary widely in the organization, with some groups exploiting the technology to the fullest, while others use OA to minimal advantage.

Researchers behaviour

IT may influence R&D activities through its impact on the behaviour of researchers. This can take any of the following forms:

* Control over information processing

* Information exchange among colleagues

* Monitoring and documenting research efforts

* Decision making about scientific issues, and the training of researchers and scientists

IT support of engineering and multimedia

Most of the published work on this issue concentrates on the impact of computer aided design (CAD) on those aspects of engineering which are close to production processes and thus not immediately relevant to the influence on engineering research and design activities.

The design process consists of four basic phases: synthesis, analysis, evaluation and representation. Some of these phases can be analyzed through well established methods, as for example, the use of finite element analysis in the analysis phase. Other phases of design rely more heavily on human judgement intuition and experience. While an ideal CAD system would automate the entire design process, the present state-of-the-art is far from that. The greatest lack of progress is in those areas that require human judgement. Thus, improvement in the situation will depend on the integration of artificial intelligence (AI) with CAD technology. We can therefore, expect that if significant progress is made in the AI/CAD integration, a marked saving of researcher's time will be possible. Should this be realized, there are three possible ways in which engineers can benefit from the saved researcher time, which namely are:

* Working on the same kind of problems, but address more of them

* Addressing problems that may not inherently be difficult, but which lie outside the available capacity of available IT, or

* Solving conceptually difficult problems leading to pushing the limits of available IT

All of these possibilities open new path ways for engineering research and design facilities.

Multimedia is gaining a lot of ground in IT applications. Multimedia programs combine computer graphics, animation, sound, and video or film into one multimedia program that can be used interactively. In R&D centres, it is gaining wide spread use as

scientists can use graphics to construct moving models of structures too small for the human eye to see (e.g., DNA molecule). As virtual reality comes to science, the use of multimedia graphics becomes essential for researchers who want to use these tools to "fly" through 3-D or 2-D maps. These new visualizations of data, numerical models or processed output gives better understanding of research problems attached and also encourage more pioneering methods of analysis [8].

5. Scientific and Technological Information Systems in a Developing Environment

This section will mainly concentrate on the role and place of information systems in the R&D environment of the Arab countries. Three main issues will be addressed, namely:

* The relationship between information centres and uses to Arab world realities
* Some specific features in the Arab information environment
* Some thoughts for improving the situation

5.1. Relationship between Information Organizations and User's

Figure 1 shows the basic functional relationships between user's and information centres (IC). The continuous interaction between the two sides is a very distinctive feature of this diagram. An important feature of the user-IC relationship is the fact that information will largely depend on the nature and objective of the task it is needed for. This really means that, for a thorough understanding of the mutual user's-IC relationship, the type of user activity and his position vis-à-vis the information he needs, must be clearly analyzed and understood.

5.2. Some Specific Features Related to User-IC Relationship in The Arab Environment

The present situation as it relates to the user-IC relationship in the Arab environment, can be characterized by the following observations:

* Modern scientific and technological information centres in the Arab world are young organizations lacking the benefit of long established experiences available

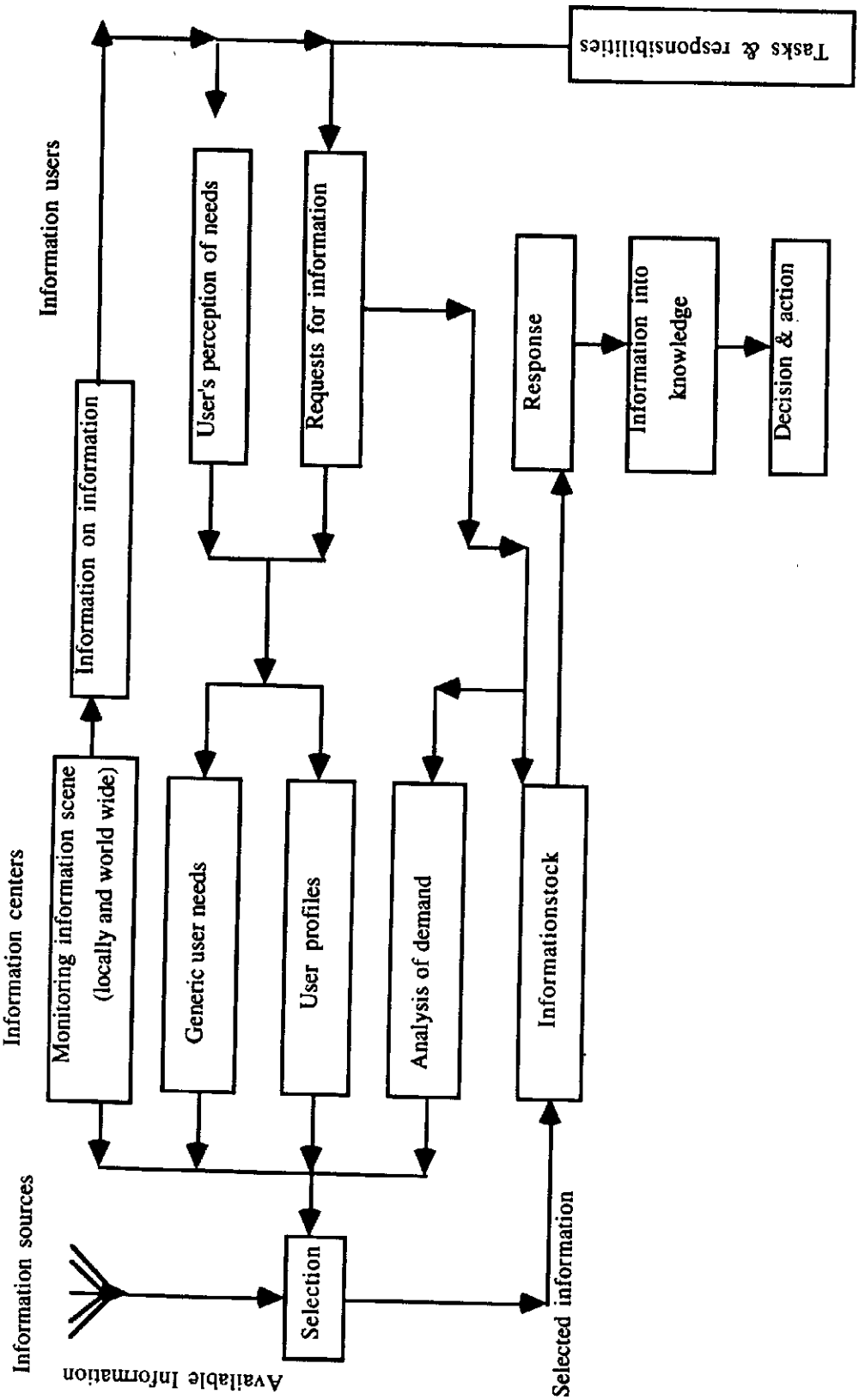

Fig. 1. Interactions between sources and users of information

to the developed countries IC's. This situation is being aggravated by the accelerating rate of generation of scientific and technological information characterizing the past decade and those to come. The lack of experienced and adequately trained Arab manpower to cope with this situation and what it involves in terms of using advanced IT and communication systems seem to be the most difficult hurdle between the Arab IT environment and its counterpart in the developed world.

* Resources allocated to IC's are in many situations, dependent on subjective views of their leadership not reflecting the real and accurate information needs of user's. This leads to a lack of definition of the types of information needed as well as their sources, volume and cost. In many Arab IC's, development on data bases is dependent on personal initiates of their leadership and what scarce opinions they receive from their few regular user's. This could, in some cases, lead to a bias in the content of databases towards a minority need.

On the other hand, the IC user's community has its shortcomings that can be stated as:

* There exists a lack of how information and IT be best exploited in order to improve R&D effectiveness and efficiency.

* The understanding of the difference between raw data and useful/applicable information is still not clear at many levels of the user's community.

* The above two constraints are further aggravated by a user's lack of a conceptual understanding of the nature of the role of IC's and the capabilities for them by modern advances on IT and telecommunications.

In conclusion, the overall picture of the information seen in the Arab countries can be summed up as one in which there is a reasonable level of scientific and technological information resource and service offered by the Arab IC's. This is not matched by any equal level of user's appreciation of the role of information and IT in the advancement of R&D and the enhancement of decision making capabilities.

6. Management Information Systems Related to R&D in a Developing Environment

The development and establishment of management information systems in an R&D organization are not just a technical matter. It is an issue that also involves the strategic concerns of top management. Technology, and especially information technology defines the range of strategic options available and the means of their

achievement. The choice of a particular approach to implement is, in the final analysis, a top management decision dependent on organizational and environmental considerations. If top management does not actively participate in, lead and direct this decision making process, then the chosen approach is likely to become undermined by an unsuitable tactical decision and actions leading to loss of control and deviation from the chosen strategic direction.

In this section, we will consider issues relevant to the planning and implementation of a management information strategy in a developing R&D environment.

6.1. Mission and Objective

The overall mission of the information function is to promote the use of computerized tools in matters relating to the R&D organizations main business objectives and to offer advice to top management on computerization and information policy matters.

Objectives.

1- The first objective is to identify the organizational needs in terms of computerized tools whether in areas of research or support services.

2- The second objective is to offer advice on computerization and information policy maters. This calls for:

* A substantial and sustained inflow of information on global development of computerized application areas and its effective dissemination with the R&D organization, and

* An ability to assess and forecast the paths such development might take in the future.

The above general objectives can lead further to more specific objectives related to R&D in a developing environment.

Specific Objectives.

1-- Specific objectives relating to research activities:

* To help improving the productivity of researchers through the development of planning and control systems to help manage and encourage the achievement of revenue and cost targets by the research teams.

* To make the utilization of research equipment and materials more effective.

* To control and reduce project related costs through rationalization and upgrading cost reporting systems.

* To make the staffing of research projects more effective by providing accurate and timely information on:

- Manpower requirements
- Manpower availability
- Training requirements
- Manpower costs
- Performance evaluations
- Career plans

2-- Specific objectives relating to support services:

* To reduce the staffing and costs of support services by automating existing information systems and related manual procedures.

* To improve the return of the investment in computerized research and analytical tools and associated technical support.

* To reduce and control cost relating to internal communications, through installation and rationalization of word processing, telephone and electronic mail networks.

3-- Specific objectives relating to planning and control:

* To increase revenue resulting from the research activities role as an information provider to the R&D institution.

* To provide performance related information about the functions whose performance is critical to the overall success of the R&D organization.

6.2. Guidelines for Planning and Implementation of Information Systems in a R&D Organization of a Developing Environment

The planning and implementation of information systems have to take account of the following considerations:

* The identification of external opportunities and internal organizational strengths will increase the probability of success in achieving information systems objectives.

* The recognition and awareness of external threats and internal organizational weaknesses which are likely to constrain the successful implementation of information systems.

* An awareness that in a typical R&D organization of a developing country, the organization comprises occupational and functional groups with both complementary and conflicting objectives. These will have a direct impact on the pace at which the information systems can be implemented and accepted.

* The existing management style may not be entirely supportive and conductive to the implementation process.

* The prevailing organization structure, channels of communication and delegation of responsibilities may not be fully supportive of the new approach to information systems.

Many organizations are turning to a new way of computing architecture called "client/server" architecture. This form of computing structure maximizes the use of all CPU available in a computing environment. PC's that are very common and growing in power and size in any institutions are fully utilized in client/server architecture rather than used as dump terminals. Client/server architecture is a form of distributed processing where usually more than one processor is involved. This means that applications are split into two parts; one is the user interface that normally runs on the user's personal computer and the other part is the database server that is shared by all user's and does all the heavy duty file crunching. Between the two is a local area network. Most R&D institutions that were established up till the 1990's, most probably have central processing environment (mainframe). Now to turn into client/server architecture, it is not quite easy because not only cost is involved, but retaining of computer centre personal is needed and this is not a simple job of a few

training courses. What is involved here is a complete re-thinking of the computing environment and re-generation of software packages that support the institution. It must be stated here also that the movement towards client/server architecture came from two business trends; seeking cost-effective operation and utilization of the computing power in desktop computers.

Before developing client/server applications, the following are needed:

* Fibre optics data distribution interface (FDDI)

* Appropriately equipped local area networks connected through fibre optic backbone.

* Database servers.

* Disciplined methodology for software development (use of CASE tools).

Use of CASE tools (Computer Aided Software Engineering) is gaining wide spread use in software system development because of several factors, most important of which ability to model processes and automatic generation of software codes. The process of prototyping and alterations can easily be handled when using CASE tools [9].

Concluding Remarks

The impact of IT on R&D and particularly on researches, engineers and scientists are much more profound than what is generally perceived by social scientists. In the developing Arab countries, such positive impact of IT has not produced its full advantage due to several factors. The following is thought to be the most important of such factors:

* Information centres that make full use of modern IT in the Arab countries are scarce and their resources are usually not adequate.

* Most IC's do not adopt objective and systematic approaches to the assessment of user needs.

* Users, on the other hand, are not fully aware of the impact of IC's on the efficiency and effectiveness of their research activities.

* User's, in general, do not have sufficient skills to effectively use information in order to transform it to "knowledge" applicable to their work.

* The R&D environment is fraught with frequent strategic changes which do not provide the organizational stability necessary for establishing IC's based on modern IT.

Introducing IT to R&D centres must be done in an organized manner; first formulating a strategic 2-5 years plan, then devising, a yearly plan of action. The strategic plan should cater for all existing constraints and foreseen ones in the future. The plan should call for a step-by-step approach while introducing IT and is to be composed of three distinct parts; IT technologies needed, software packages needed and human resources development. Of course, before a plan can be devised, information should be collected and analyzed to assess the existing information infrastructure. The overall objective of the strategic plan will be how to enhance the performance of the R&D centre. The yearly plan of action should also be carefully thought off and administered by upper management so as to ensure co-operation among departments concerned.

Introducing IT to R&D centres will imply the following:

* Office work will be highly automated (reduction of paper work).

* Communication among researchers will be further enhanced and information flow will be very easy (e-mail, etc.).

* Information (data, images, etc.) gathered, analyzed and processed by scientists will be residing in electronic data banks for easy access.

* Entity output will be very efficient (systems, databases, numerical models, etc.).

* Scientific productivity will be enhanced.

* Corporate planning will be very efficient and effective, i.e., maximum utilization of resources.

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تكنولوجيا المعلومات في بيئة البحث والتطوير

عبدالهادي العتيبي
نائب المدير العام للمعلومات
معهد الكويت للأبحاث العلمية، ص ب : ٢٤٨٨٥ ، الصفاه ١٣١٠٩

(قدم للنشر في ١١/ ٠٩/ ١٩٩٤م، وقبل للنشر في ٢٠/ ٠٢/ ١٩٩٥م)

ملخص البحث . نناقش فيما يلي قضية تأثير تكنولوجيا المعلومات على نشاطات البحث والتطوير بشكل عام وعلى الباحثين والعلماء مع إلقاء الضوء على نقص وغياب المعلومات المتعلقة بتأثير تكنولوجيا المعلومات الحديثة على العلماء والمهندسين من منطلق الخواص العامة والشمولية للعلاقة التي تجمع بينها وبين البحث العلمي. من جهة أخرى سنلقي الضوء على المعلومات الحديثة والفهم المعاصر لهذه العلاقة. وذلك خلال تلمس دور الحاسبات في عمليات البحث والتطوير وموقعها من قطاع الانتاجية العلمية في المجتمع. كما تتم مناقشة قضية التفاعل بين تكنولوجيا المعلومات مع ممارسات البحث العلمي من زاويتين الأولى متعلقة بالجانب التجاري لإدارة مؤسسات البحث والتطوير في حين تنظر الزاوية الاخرى إلى الجوانب التي تؤثر وسلوك الباحثين والمجموعات وفرق البحث في المؤسسة، هذا إلى جانب موضوعات وقضاياأخرى تناقش سيتم إثارتها مثل تأثير تقنيات المعلومات في مؤسسات البحث والتطوير في الدول النامية مع التركيز على أهم العوامل والفوارق التي تميزها من دول العالم المتفوقة وستتم أيضاً مناقشة بعض الجوانب الخاصة الأخرى فيما يتعلق بعلاقة مراكز المعلومات بالمستفيد منها في الدول النامية.

وبشكل عام يمكن تلخيص وضع المعلومات في الدول العربية النامية بأنه هناك مستوى معقول من موارد المعلومات العلمية والتكنولوجية الا أنه لا يقابله مستوى مماثل من تقدير المستفيدين للدور الذي تلعبه تكنولوجيا المعلومات في تطوير وتعزيز عملية البحث والتطوير في المجتمع .