On Some Issues of Information Resource Management in the 1990s

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The basic objective of this paper is to provide an overview of key information resource management (IRM) concepts. This is done using a three-stage framework for its implementation. The discussion focuses on three areas: planning for the acquisition, organizing, and control of information resources in an organization. A concise strategy for the planning process is also presented here. While the underlying IRM concepts are relatively simple, we have to be aware of some hindrances that are likely to be encountered during planning and implementation. We offer some guidelines, on the basis of our own experience and existing literature, as to how these issues can be resolved. Finally, any new IRM initiative has to consider the changing role of computing technology and its practice. Therefore, a separate section has been researched into to provide details of the new technology of the 1990’s and its influence over all aspects of IRM.

Information resource management (IRM) is a relatively new management concept that emerged in the past decade. It is concerned with the management and use of information technologies. IRM regards data, information, and the computer with its accessories, as an integrated collection of valuable organizational resources. It aims to provide guidance for their efficient and effective management. The principal advantage with IRM is the availability of timely, high quality information, and improved overall productivity. This is achieved by (Corbin, 1988)

(a) maximizing the use of existing resources,
(b) providing compatible computing systems,
(c) managing distributed information resources satisfactorily,
(d) increasing computing support to all users.

In the U.S. Federal government, IRM is a legislated edict and, in the commercial sector, it simply makes good business sense; both continue to invest heavily in information systems technologies and IRM holds the promise of maximizing these investments (Owen, 1987).

Before we discuss the various issues of IRM, a clarification of some basic information management concepts and terminology is in order.

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Data, Information, Knowledge and their Relationship

Every organization relies upon knowledge and information to make decisions. This aspect of an Information System is explained in this section.

Management decisions, regardless of nature and scope, are based on data such as market statistics, cost and revenue estimates, inventory levels, shop floor operating data and many other factors, both quantitative and qualitative. Data in raw form, however, are not of much use for management decision making, though raw data are sometimes used for certain kinds of operating functions. It is necessary to subject the data to various processing activities such as comparison, classification, analysis, verification, calculation, summarization and communication so that they become factual information and of value to management. Information is a collection of data and facts processed in such a way that it provides the management with sufficient insight about a decision problem to which a solution is sought.

Although in everyday life the terms data, information and knowledge are used very casually and often interchangeably, in this paper we strive to make some distinction. Horton (1979) states that, “we have three levels, knowledge resources, information resources, and data resources, each with its special niche”. This will serve to acknowledge the different role played by each as an organizational resource.

Technically, the definitions of data and information according to the International Federation for Information Processing (IFIP, 1966) are as follows:

*Data:* A representation of facts or ideas in a formalized manner, capable of being communicated or manipulated by some process.

*Information:* The meaning that a human expresses in or extracts from data by means of the known conventions of the representations used.

Due to expert systems, the terms knowledge and knowledge-base have also become popular. To define the term knowledge we refer to the definition provided by the National Commission on Libraries and Information Science (NCLIS, 1975).

*Knowledge:* Information in a highly processed form.

Even though the distinction between the terms information and knowledge could get fuzzy at times, one way to distinguish them, however, is to consider that knowledge can be captured, documented and implemented as an expert system for decision making. It is therefore convenient to think of information and knowledge as two distinct resources.

From the above definitions, it is clear that the relation between data and information is that of raw materials to finished products. In much the same way that a finished product is of greater value than the raw materials of which it is made, information is of more value to management than the raw data from which it is extracted. And using the same analogy, we can regard knowledge as the finished product that is processed and refined even more. Such a distinction between information and knowledge is especially useful in the context of the knowledge-base of a firm - as residing in expert systems.

We can further define information in the context of management as a form of processed data that conveys to the recipient meaningful messages which are valuable in actions and decisions. Thus the value of information is recognized in a specific decision and in motivation, model construction and background building affecting current and future actions and decisions.

Information Resources

The electronic digital computer has proven to be, by far, the most powerful and useful data and information processing tool ever in-
vented. With advances in computer technology, on both hardware and software fronts, increasing computing power is continually available at decreasing cost.

The latest generation of computers, be it a mainframe or a micro, is extremely powerful in terms of processing speed and storage capability. This, coupled with advanced systems software, and user-friendly application software, makes it a formidable business tool for all kinds of organizations. It is capable of generating valuable information, which is timely, accurate, concise and understandable, to support a diversity of complex business decisions. Not surprisingly, the demand for computers continues to increase at a rapid rate.

Due to the proliferation of computers, data processing management has become difficult; however, at the same time, it has become more crucial than ever. Especially with the advent of microcomputers, office automation technology, and communications networks, we see a need for managing information properly in order to obtain the benefits. IRM as a concept is therefore useful here under such circumstances.

Computer and management professionals have realized that information can be and must be managed in order to obtain the benefits. Like financial and personnel resource management we see a need for information resource management. What is IRM? According to Miller (1989), it is broadly defined as, “the management of data and information - an umbrella term that includes the management of such information resources as computer hardware, software, communications, internal and external databases, planning and review, as well as the integration of these resources for the support of managing information for the organization as a whole”.

At the heart of IRM is a computer-based information system that is made up of three components; namely, hardware, software and people (see Figure 1). The hardware is a collection or system of physical devices such as a mainframe, a cluster of minis or a network of micros, together with all ancillary peripherals - including terminals, printers, disks and drives, magnetic tapes, modems and communication networks.

The software comprises of computer programs. This can be classified as either systems software - for example, the operating system, or application software - such as a payroll system.

The people component of IRM consists of various members of the data processing shop, such as the system manager, the database administrator, system analyst, application programmer and operator. Collectively, they are responsible for the operation and management of the system, and for providing quality service to the entire organization. Today, however, end user computing is a reality, and the end user should be considered to be a part of the people component.

In general, the above three components of a computer-based information system are collectively known as computer resources, which together with the basic elements of data, information, and knowledge, discussed earlier, constitute the information resource. This resource is as important and valuable as other organizational resources, such as raw materials, capital and machines, and must be efficiently, economically and effectively managed for the benefit of the entire organization.
IRM Implementation

A three-stage framework is presented in this section to guide an organization with its implementation effort. Figure 2 illustrates the three stages: planning for the acquisition, organizing IRM, and the control of information resources. Important issues and concepts related to Information Resource planning are introduced next.

IRM Planning

Planning is an important management function, and as we shall see, a critical one in the context of IRM as well. While corporate planning receives a lot of attention today, IRM planning is sometimes ignored. This could prove to be costly. Moreover, without a formal plan, it is difficult to control and achieve the basic objectives of the organization.

While computing technology is becoming more and more indispensable today, it is also becoming an expensive proposition. Planning enables us to provide the information needs economically. Before we discuss some key planning issues it would be worthwhile to explore the planning process briefly.

System analysis and planning requires both top-down planning and bottom-up design (See, for example, Anthony, 1965; Hodge and Clements, 1986). Top-down planning starts with basic organizational goals and objectives and applies a business planning methodology to analyze organizational functions, processes, systems, activities and entities. An information model is then developed that shows the major entities of the organization and the relationships among those entities. The ensuing system design is a bottom-up process in which analysts collect user opinions and expectations of the system and develop detailed system specifications which must be cross-checked against the information model to ensure that they are complete, accurate and consistent with the information needs of the organization.

A key issue here is the selection of a complete planning methodology itself. There is an array of planning methodologies available from which an organization can choose the ones most suitable for its various phases of information system planning. Some of the more widely employed planning methodologies are business systems planning (BSP) developed by IBM, strategy set transformation (King, 1978), critical success factors (CSF), ends/means analysis (Wetherbe and Davis, 1982), chargeout, zero-based budgeting (Pyhrr, 1970), milestones, Gantt charts and program evaluation review technique (PERT). All of these are general planning methodologies and they can easily be adapted to information system planning, at both the strategic and tactical levels. Following the planning of the overall information system are the analysis and design of the various subsystems. The relevant decisions that an organization will have to make here are concerned with data organization and database system design,
data communications system design, management information and decision support systems design and the like. A host of demonstrated methodologies for the design of these systems has been documented in the literature, see, for example, Martin (1982).

Below we present a concise description of the planning process (see Figure 3). It is discussed under three topics, strategic planning, requirements analysis, and designing development plan and project selection.

Strategic Planning: During this stage a high-level overall plan for the organization is defined. General objectives and goals of the organization are considered here. The environment is assessed, its needs, and the DP department’s track record (if one exists) is evaluated. Once this is done it is possible to identify various strategies and define policies and procedures. For example, the database strategy is evaluated broadly and compared with the traditional file processing approach, and the costs and benefits of using any one approach are identified. Finally, the IRM mission is identified and documented.

Requirements Analysis: The current information needs are identified, and projected needs are estimated. A master architecture plan is designed. This is typically an enterprise model (EM) of all of the organizations information needs.

Designing Development Plan and Project Selection: A multi-year development schedule is identified, and a resource requirements plan is drawn up. Crucial applications are identified and targeted for development, and priorities are established. On completion of the EM it is possible to identify general logical views of the information needs and purchase a suitable database management system for the organization.

Strategic Planning and Requirements Analysis are crucial stages for an organization and several major problems in IRM can be traced to this stage. According to Callahan in an interview with Khosrowpour (1989), three areas that present big challenges in management of information resources are:

(a) having an external focus, i.e. making a serious effort to accommodate the needs of the customer via the functional areas of sales, marketing and distribution,
(b) closer linkage with the strategic planning process, i.e. considering information technology as plans and strategies are designed,
(c) interaction and involvement with management during formulation of tactical plans. The above issues should be kept in mind during the planning process.

From our own experience, IRM could be introduced in the organization as an evolutionary process, or as a revolutionary one. In the evolutionary approach individual systems are installed to solve specific application problems. This approach is preferable if an organization is not currently interested in making a major commitment to installing automated information systems, or cannot afford a high level of involvement. The solu-
tions could range from small standalone workstations to local area networks of microcomputers. The problem with such a strategy, of course, is that incompatible computing hardware and software might get installed at various stages, creating information management problems in the future.

In contrast to the above, some organizations might prefer the revolutionary way. In this approach, complete information systems and office automation software are introduced in one step. Prior careful planning and investigation must be carried out if failure is to be avoided. Moreover a high level of commitment from all members of the organizations must be available. This is rarely possible and therefore the revolutionary approach should be examined carefully.

Another important planning issue that any organization contemplating implementation of a computer-based information system and functioning under an IRM environment must tackle is acquisition of information resources. Since investment in computer resources, i.e. the computer hardware, software and people, involves substantial capital outlay, careful planning is absolutely essential to minimize the risk of making an inappropriate decision. An incorrect decision would prove to be extremely costly and difficult to rectify.

It is quite common that an organization will acquire its computer resources from a diversity of sources. This is partly due to the fact that the computer industry is so highly specialized and technology-oriented that it is very difficult to find a single supplier able to provide all the necessary computer resources required by the organization. Also the conventional wisdom dictates that an organization should go for multiple vendors to avoid too much reliance on a single supplier. Therefore, the organization should have a basic understanding of the computer industry. Frequent contacts with suppliers in the computer industry are needed to secure their continual support and provision of up-to-the-minute information on new developments in computer technology. A quick but expensive way to acquire a working knowledge of the computer industry is to engage the services of a computer consulting firm. They should be able to give expert advice on the computer requirements of the organization and to make recommendations on resource acquisition.

The next decision issue is concerned with the question of whether one’s own computer resources in-house or contractual external resources should be used. Many organizations rely on external agents such as time-sharing companies, computer services and facilities management consultants to provide the required services. The main advantage of this option is substantial saving in capital investment, but the trade-offs are loss of control over the system, higher risk of system abuse, long response time and high long-run unit costs. Although there is no easy and clear-cut resolution of this issue, our experience suggests that external services may be appropriate for organizations planning partial computerization. An organization aiming for total computerization should have full control over its computer resources.

Evaluation of potential computer resources is an important planning issue. The usual approach is to invite potential suppliers and manufacturers to submit bids and proposals, on the basis of system specifications developed after careful analysis and design of the system. Evidently a formal evaluation process will help minimize the chances of acquiring incorrect or unnecessary equipment and products. Common factors used for assessment of computer resources include cost/performance ratio, system mean-time-between-failures, availability of spare parts, ease of maintenance, after-sales service, software reliability, technical support, user training and potential for growth. Couger and Knapp (1974) have discussed a number of techniques developed to assist in system evaluation, among which the cost-benefit analysis is the most powerful and versatile. A cost-benefit analysis helps identify both tangible and intangible costs and benefits to be derived from the proposed system. In addition, it is also essential to conduct a formal evaluation of various financing methods, such as hire purchase, rental, purchase or lease arrangements, employed
to finance the computer resource acquisition project.

Cost control of computer resources is the next issue that needs to be resolved. Tight control over the project cost is vital to ensure that budget limits are not exceeded unnecessarily. Hardware costs used to, and still do, account for a significant proportion of total capital outlay, but they are decreasing steadily over time as competition in the computer industry intensifies and more powerful and low-cost micro-electronics continue to be developed and added to the market at an accelerating pace. It is estimated that there is a growing trend toward higher software and personnel costs due to an escalation in the cost of developing and maintaining new application programs (Marison, 1984). Thus, an organization must plan for the establishment of a cost-control program aimed to keep a rein on the various cost items incurred in the design, development, operation and maintenance of a computer-based information system and in the administration of the system personnel.

**IRM Organization**

This is the second stage in the IRM implementation framework. It is concerned with organizing a firm so that it can function effectively in an IRM environment. The issues are largely dealing with the grouping of computer resources into logical and efficient units in order to carry out the firm’s plans and achieve its goals successfully. There are three basic issues to be addressed which are discussed below.

The decision of centralization versus decentralization of authority is the first organizational issue that needs to be addressed. A high degree of centralized control is made possible by the installation of a computer-based information system which can be designed to automatically collect and transmit undisguised information from dispersed functional units in a reliable and timely fashion to top management for appropriate decision making. Although centralization has become a reality and decentralization can be reduced to a minimum level, whether an organization should pursue this option or not remains an organizational decision that depends on the long-term objectives, management style and philosophy of the company, and a host of other factors. As with all kinds of decisions, the pros and cons must be carefully weighed with reference to the business in which the company is engaged and the environment - economic, political, cultural, technical and legal - in which it operates before the final verdict is delivered.

Another organizational design issue for IRM will be the degree of centralization and distribution of computer hardware, software and system personnel and storage of information. In the centralization approach, there is a main processing centre in which all system hardware, software and personnel will be placed, as will all data and information storage. The main advantages of this approach are economies of scale in resources usage, division of labour, standardization in equipment and products. However, the disadvantages associated with this approach are inflexibility and a low service level from the point of view of the users. These shortcomings can easily be remedied by adopting the distributed approach in which each individual functional unit has its own computer resources but they are connected up by a company-wide communication network to facilitate resource sharing. Since each of these approaches has its own merits and demerits, it is hard to decide which one is more beneficial without considering other organizational factors such as size of the firm, nature of business, span of control and management style and philosophy of the organization. Nevertheless, our own experience favours a hybrid, or information centre (IC), approach tailored to meet the requirements of a particular organization will be the best option to follow. In fact, the IC approach has in recent years gained considerable popularity among companies, since it not only allows a firm to have centralized computing resources but also makes computing power available to the end-users closer to their work places.

Next comes the issue of deciding the organizational position of the information system unit relative to other functional units in the orga-
ization. Dickson and Wetherbe (1985) have identified three most likely locations in which the information system unit can be placed, viz. the unit can be placed under the control of
(a) the finance and accounting department,
(b) a steering committee with representatives from all functional units, or
(c) the chief executive officer (CEO).

Dickson and Wetherbe (1985) have discussed the pros and cons of these locations and have come to the conclusion that the information system unit needs to take as broad a view as possible to be most effective. They offer two guidelines associated with placing the information system unit in the overall organization. First, a higher level of reporting of the information system function will give the function a better chance to succeed. Second, it is far better to have the information system unit report to a general administration function than to a specific function such as accounting. This will meet the need of the information system function to have as broad a perspective as possible regarding systems priorities. They then go on to suggest that option (c) above be the most preferred choice because in such a case the unit reports directly to the CEO and operates as an independent functional unit with high organizational status and responsibility. Therefore any improvement in the system deemed necessary and beneficial to the entire organization is easier to undertake as fewer obstacles are in the way. A recent Peat Marwick and Partners Electronic Data Processing (EDP) compensation survey (1988) indicates that in a large organization the Director of IRM is commonly located below Corporate Vice-President of EDP. The IRM Director here is directly responsible for the entire Data Base group and the Information Centre (see Figure 4).

Even though the exact placement of the IRM function may vary from one firm to another depending on the role and tasks assigned to it, in our opinion, it should preferably be located at a higher level of the organizational hierarchy. This would represent a strong commitment by the organization to the IRM approach.

**IRM Control**

This is the third and final stage of the IRM implementation framework. Associated with the use of a computer-based information system in a firm are a number of control issues and their implications for the security of the resources and control over the use of the system. It is of paramount importance to institute adequate protection and exercise tight control over the system to ensure integrity of data and information, efficient and effective operation of the system and insulation of the system from potential intentional and natural disasters.

The various computer resource control issues can be classified into three categories (See, for example, Nordbotten, 1985 and O’Brien, 1985):
(a) processing controls,
(b) organizational controls,
(c) facility controls.

While an extensive treatment of various security-related problems is given in Martin (1973) and a detailed discussion of each of these categories of controls is found in O’Brien (1985), we make several summary comments regarding the control issues in the following.

Processing controls ensure accuracy, validity and propriety of data processing functions and activities and can be organized according to the input, processing, output and storage components of an information system. Thus there are activities to maintain the accuracy and integrity of all data input into the system. There are software and hardware controls to detect and rectify errors arising from data processing. A variety of checks such as validity checks, reasonableness checks, sequence checks, control total checks, and the use of check points can be used to perform software controls. Hardware controls require special checks built into the hardware to verify the processing accuracy of the computer which include parity checks, multiple read-write heads, malfunction detection circuitry, switches such as the write-protect notch on floppy disks. In addition, output controls are exercised to ensure output
information is correct and complete and is released to authorized users in a timely manner. Finally storage controls are designed to prevent unauthorized or accidental use of stored information. A common and effective method for storage controls is the use of identification codes such as user identifications and pass words to restrict access to all or specific portions of the information and data files to authorized users only.

Organization controls are set up to facilitate the accuracy and integrity of computer operations and systems development activities. The various functions an organization should undertake are

(a) production control - monitoring of the progress of information processing jobs, data entry activities and input/output data quality,
(b) separation of duties - assigning the duties of managing and operating the information system to different groups,
(c) standard procedures - maintaining sets of
standard procedures for performing different system functions,
(d) documentation - developing and keeping up-to-date documentation about the system hardware, software and their operation and maintenance procedures,
(e) authorization requirements - requiring all system changes to be subjected to a formal process of internal and/or external reviews,
(f) conversion scheduling - setting up formal notification and scheduling procedures and allowing adequate time for all system conversions and modifications,
(g) information services auditing - conducting periodic evaluation and reviewing the quality of service and examining the activities performed by the information system.

Facility controls are methods that protect the physical facilities and their contents from loss or destruction. Computer resources are exposed to all kinds of hazards; physical protection and control procedures are necessary to protect hardware, software, system personnel, data and information. The various protection and control measures that should be taken are:
(a) database controls - maintaining control over system programs, software packages and data files,
(b) data communication controls - encoding and decoding data before and after transmitting them through communication networks to prevent intentional or accidental interception,
(c) system failure controls - installing control procedures to prevent computer failure and to minimize its effects in the event that failure should occur,
(d) physical protection controls - providing tight security and disaster protection for the system hardware, software and personnel,
(e) insurance - providing adequate insurance coverage to protect the organization from the financial losses and liabilities resulting from accidents, disasters, fraud, negligence, vandalism and other potential risks arising from operating, maintaining and using the information system.

The 1990’s Technology and Impact on IRM

This section is devoted to an evaluation of the new technology and its influence on IRM. Basically, this can also be investigated under three categories, people, hardware and software (see Figure 5).

People: With increased proliferation of technology both at the workplace and at home, we will see a very computer literate workforce in the future. Such a workforce will not only hesitate to use the computer freely and effectively, but will also think of innovative uses of technology. With further improvements in communications technology, we will also notice a tendency towards distributed data processing. It would not be strange anymore to have some employees do the secretarial work from home, for instance. Indeed, entire data entry and document preparation can now be done far away from the work site, quite economically and efficiently too.

One of the important concerns in the 1990’s would be to bring together relevant information and knowledge at the point of making decisions. It is possible that readily available, but irrelevant, data might be used to provide misleading results.

Hardware: In the past, computer technology was affordable only to large corporations, but in the nineties, we will see it play a very significant role in every business, small or large, due to the introduction of powerful, inexpensive microcomputers. Peripherals will continue to become more intelligent and well-integrated into the work environment along with the computer. For example, modems and fax machines have already become a part of several computing systems and they pro-
vide a powerful capability to transfer data and information from one location to another. The new office of the future will have hardware capable of transmitting, storing or retrieving electronic documents with pictures, data, text and even voice to facilitate better communication.

**Software:** Software can be investigated in the context of tools and techniques for the 1990’s. We will continue to see an increase in sales of vendor software. In the eighties we saw a standardization emerge in the computing industry of spreadsheet software, such as Lotus 1-2-3, and database software, such as dBASE. However, with greater use of microcomputers in all organizations, we will see in the nineties a need for more software tools, such as specialized accounting software, communications software, scheduling software, office automation software (based on LAN). Decision making software such as spreadsheets will continue to become more friendly and powerful, and database software will also incorporate a knowledge-base, image retrieval and processing capability.

While small to medium organizations can rely on vendor purchased software, large organizations will, of course, continue to develop software in-house. Information system practitioners in such firms should fully use techniques such as Computer Assisted Software Engineering (CASE), End-User Software Development, Joint Application Development (JAD), Rapid Application Development (RAD), and Object-Oriented
Programming (OOP) to enhance their software development productivity and efficiency. Knowledge-based techniques have finally begun to pay off in several organizations, and will continue to do so in the nineties, due to integration of expert systems with existing databases and information systems.

Integrated telecommunications, networking and distributed data processing will be the backbone of the integrated office system of the future providing interesting applications including: video-conferencing, high-speed facsimile, multi-lingual translation, and rapid transfer of funds and transactions.

In conclusion, IRM professionals responsible for defining strategies must be aware of such trends in IRM as they will shape the industry of tomorrow.

Conclusions

We have discussed in this paper several issues pertinent to successful and effective information resources management. Symptoms of deficiency in IRM can be identified as (Friedlander, 1985): poor data quality, non-compatibility of data, data redundancy, inability to manage computing usage, and escalating costs.

Even today, effective management of IRM is critical:

(a) due to the low cost of technology, computer equipment proliferation is taking place at a rapid rate,
(b) in order to stay competitive in business, organizations must make quick and efficient decisions, provide accurate and timely information, and offer quality service to the consumers,
(c) cost of human resources has increased sharply and management is under pressure to increase the productivity of their employees.

We have presented a three-stage framework which focuses on the planning for the acquisition, the organizing, and the control of information resources in an organization. We have also attempted to offer some guidelines, on the basis of our own experience and existing literature, as to how these issues can be resolved.

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