

An Analytic Approach for Planning Computerized Office Systems

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The increasing demand for timely business information as well as the need to improve the effectiveness of administrative operations are forcing managements to consider installing automated office systems. These systems provide text word processing capabilities, information management and communication options. Their planning and evaluation process considers decision issues that are, at times, in conflict with each other. This paper presents a decision framework for the planning and evaluation of computerized office systems. Attention is focused, in particular, on the selection and the integration of word processing systems in the broader context of future office developments. It evolved from several real acquisition cases where such systems had to be planned, evaluated and selected.

1. PROBLEM OVERVIEW

THE COMPUTER revolution is impacting the modern office operation in many ways that, just a few years ago, were not even thought of. The price reduction trend offered in the mini computer market and performance improvement trend of available micro computers have resulted in a modern office having greater potential capabilities [14, 20, 35].

The increasing demand for information processing, data transfer, storage and retrieval, is causing office operations to be labor-intensive. To cope with these demands and with the contemporary operations complexity the computer power is harnessed to assist in the daily activities. This shift from manual paper work to electronic hardware results in improved productivity, job satisfaction and service to customers [21]. The need to improve productivity and effectiveness is forcing organizations to invest more of their resources into novel electronic services [42]. These include the various combinations offered through computers, communication links and remote access capabilities that contribute in automating office operations. The potential for automating office operations lends

itself to support the vision of the so-called 'office of the future' [35, 40, 43].

The capabilities envisioned for the office of the future include many aspects of present and future endeavours. For example, the incorporation of data communication links may provide electronic mail services, teleconferencing (audio or video), electronic filing and retrieval (remote and on-site), facsimile transfers, teletext, access to public/commercial data-bases as well as various word processing and local text management services [6, 11, 15, 23, 36, 39].

Each of the above-mentioned capabilities presents management with difficult decision problems concerning the adoption, evaluation and selection of specific systems. While some of these technological offerings are on the distant horizon for some organizations, others are already pressing decision problems concerning immediate adoption. Recent studies indicate that by starting with proper planning, organizations can benefit early from office automation technology having long-term growth potential [7, 12, 16, 31]. A case in point is the introduction of word processing systems to enhance office performance.

Word processing systems allow the entering, storing, retrieving, editing, manipulating and merging of various textual records [24]. These systems appear either as stand-alone stations composed of keyboard, screen, printer and storage devices or as more complicated configurations. Typically, the larger word processing systems are clusters of several work stations organized around one central processor, or in a form of a network where each node has its own processing capabilities. The latter configuration results in greater reliability (stand-alone operability) but at a higher cost [40]. Various performance levels (by a number of measures) can be attained from systems with differing configuration and costs. This leads to an involved multicriteria decision problem for the prospective users since no single system dominates its competitors in all measures of importance. For example, one system may offer an excellent text editor and appropriate storage device while having limited communication capabilities and a poor service record. In addition, one has to assess the relative contribution of specific performance levels on the overall office productivity.

This paper offers a model for addressing the relevant issues, criteria and technical parameters that form the decision basis for the determination of word processing systems. The model casts the problem in a framework that also considers major future options for office automation.

The methodology chosen to analyze this multicriteria decision problem, and to define the impact of all performance levels on office productivity, is the Analytic Hierarchy Process (AHP) developed by TL Saaty [27]. The next section provides a brief discussion of the AHP methodology. Section 3 presents the analysis framework. Section 4 conducts the priority assessment and Section 5 provides the interpretation of results.

2. METHODOLOGICAL BACKGROUND

A major problem in decision making is the structuring and analysis of complex, multi-person, multicriterion and multiperiod decision problems. An approach for dealing with this multitude of issues is offered through the AHP recently introduced by Saaty [27, 28]. This sec-

tion presents a brief summary of the methodology.

The AHP starts by decomposing a complex decision problem into a hierarchy; each level consists of a few manageable elements and each element is, in turn, decomposed into another set of elements. The process continues down to the most specific elements of the problem, typically the specific courses of action considered, or the decision variables, which are represented at the lowest level of the hierarchy.

In constructing general hierarchies, the following guidelines should be remembered:

- (1) The *number* of levels used in a particular hierarchy is not fixed and should be chosen to reflect the particular problem at hand.
- (2) The *order* of the levels should be one that reflects a logical causal relationship between adjacent levels.
- (3) The number of members in a particular level should be chosen to describe the level in adequate detail.

Structuring any decision problem hierarchically is an efficient way of dealing with complexity and identifying the major components of the problem. There is no single general hierarchical structure, and one of the major attributes of the AHP is the flexibility it allows management in constructing a hierarchy to fit their idiosyncratic needs. When hierarchies are designed to reflect likely environmental scenarios, corporate objectives, current and proposed product/market alternatives and various design options, the AHP can provide a framework and a methodology for the determination of a number of key decisions.

Following the structuring of a hierarchy that addresses the decision problem, a measurement methodology [25] is used to establish priorities

TABLE 1. COMPARISON SCALE

Intensity of importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong or demonstrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values between adjacent scale values

among the elements within each stratum of the hierarchy. This is accomplished by asking the participating decision makers to evaluate each set of elements in a pairwise fashion with respect to each of the elements in a higher stratum using values taken from the scale described in Table 1. This measurement methodology provides the framework for data collection and analysis.

This pairwise comparison of n elements is summarized in a comparison matrix A given by:

$$A = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{bmatrix} \quad (1)$$

The information displayed in this matrix is interpreted as follows: every element, a_{ij} , of the matrix A shows the relative contribution—to the subject of comparison—of the i th activity as compared to the j th activity, i.e.

$$a_{ij} = w_i/w_j \quad 1 \leq i \leq n, \quad 1 \leq j \leq n. \quad (2)$$

The actual entries are derived by using the scale described in Table 1.

Note that the matrix is a *reciprocal* matrix, i.e. $a_{ij} = 1/a_{ji}$. Therefore, whenever the ij th element of the matrix is filled out, the ji th position is automatically filled out by its reciprocal value.

To actually recover the weights, w_i , rather than their ratios that are given in equation (1), we proceed as follows. Note that:

$$Aw = nw \quad \text{where} \quad w^T = [w_1, w_2, \dots, w_n] \quad (3)$$

and since equation (1) can be factored out as:

$$A = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} [1/w_1, 1/w_2, \dots, 1/w_n] \triangleq A_1 A_2 \quad (4)$$

It can be shown that the eigenvalues of equation (4) are found from:

$$\begin{aligned} \pi(A) &= |A - \lambda I_n| = |A_1 A_2 - \lambda I_n| \\ &= (\lambda)^{n-1} (n - \lambda) = 0. \end{aligned} \quad (5)$$

Hence, a comparison matrix as given in equation (1) has $(n - 1)$ of its eigenvalues at the origin and one eigenvalue is equal to the dimension of the matrix A , i.e. the number of activities compared.

Since $\lambda = n$ is the largest eigenvalue, one concludes that the vector of priorities, w , is obtained from equation (3) and is simply given as the (normalized) eigenvector of the matrix A corresponding to the largest eigenvalue $\lambda_{\max} = n$.

When inconsistencies occur, i.e. $a_{ij} \neq a_{ik} a_{kj}$, this largest eigenvalue is greater than the dimension of the matrix, n . A consistency index is defined by $CI = (\lambda_{\max} - n)/(n - 1)$. The use of this index identifies those comparisons where revision of judgement is necessary; this is done when the consistency ratio (CR) is greater than 0.1; more on this subject is found in [27].

When more than one level is involved, hierarchical composition is used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level and so on, resulting in a global priority vector for the lowest level of the hierarchy. Figure 1 depicts two adjacent levels (i and $i + 1$). Each level has its own decision elements denoted by $A_i(i)$. If one compares the elements of level $i + 1$ with respect to $A_i(i)$, a comparison matrix will result whose eigenvector describes the relative *local* priorities of elements in level $(i + 1)$ with respect to $A_i(i)$. Let us denote this vector by w_i . Similarly, comparisons are made with respect to each of the n elements in level i . This process results in n m -dimensional ($m =$ number of elements in level $i + 1$) local priority vectors. The principle of hierarchical composition is now applied to find the *global* priorities of elements in the $i + 1$ level; these are given by:

$$\begin{aligned} p(i + 1) &= [w_1, w_2, \dots, w_n] p(i), \\ w_i p(i + 1) &\in R^m, p(i) \in R^n. \end{aligned} \quad (6)$$

The AHP methodology discussed above has been used in a number of applications including national economic planning [28], marketing strategy [38], resource allocation for R&D [27], option generation for decision analysis [2] and other cases [17, 26]. It differs from the classical multiattribute utility approach [10] in that the deterministic nature of the problem permits direct value assessment, rather than resorting to assessment of risk attitude. The latter approach

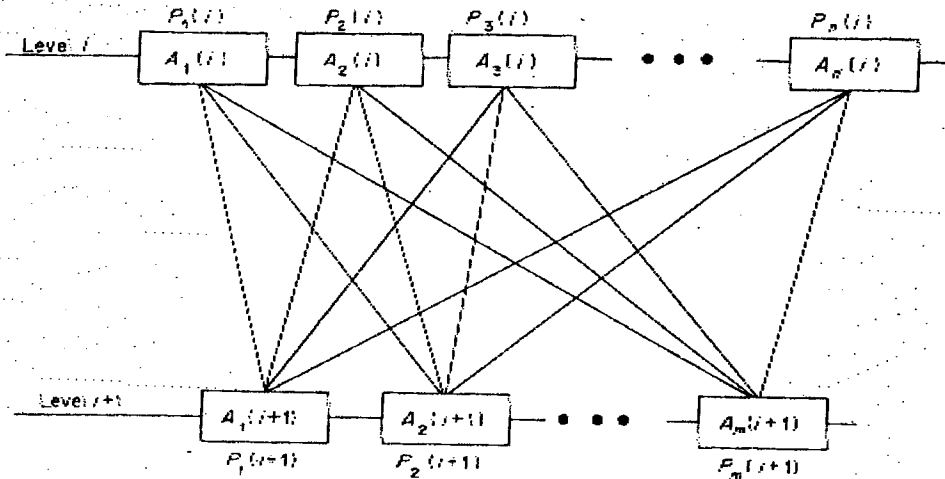


FIG. 1. Hierarchical composition.

results in multiattribute utility curves, while the AHP results in a single priority point in the attribute space which describes the overall merits of the system [13, 30].

3. ANALYSIS FRAMEWORK

The analysis framework is composed of two stages: the hierarchy formulation and the priority assessment. In the first stage, one considers decision factors having a bearing on the problem of incorporating a word processing system into an office automation effort. These decision factors consider such items as: corporate requirements in installing a word processing system, operational criteria and technical parameters. Listing elements in these distinct categories is done by eliciting opinions from various decision makers having different responsibilities and expertise and by using information flow analysis tools [18, 33]. These opinions are integrated into a cohesive hierarchical framework whose levels depict logical dependence of these major groups of decision factors. In addition, the hierarchical framework considers specific candidate systems to be selected. These are determined by the pre-screening process contrasting the various vendors' proposals passing the minimal operational requirements. Next, one enters the prioritization stage. Here one is concerned with the determination of priorities associated with the decision elements formulated at the first stage. These priorities permit direct comparisons between systems to be made. The selected system is the one resulting with the

highest priority. This complete process is depicted in Fig. 2.

In structuring the hierarchy one has to consider the various levels and their interdependencies. In the first level, the corporate office automation requirements are considered; specific items include *enhanced productivity*, *text generation*, *information management* and general office automation *infrastructure development*.

The second level addresses the operational criteria used in support of the relevant corporate requirements. These criteria include *capacity*, *ergonomics*, *lead time*, *quality*, *data storage* and *enhanced performance*. The capacity criteria relates to the ability of the system to enter data and to process output during a given time period. The ergonomics criteria is concerned with 'user friendliness' in both hardware and software aspects [4]. Lead time is an important factor affecting both the text generation capabilities (first level) and the productivity of the system. This criteria is applicable to both document generation and document retrieval lead times. The next element, that of text quality, deals with the ability to generate error-free documents, various text layouts and quality printouts. These are denoted in the hierarchy by *text integrity*, *document design* and *output quality*. Data storage deals with the *active storage* used during the text generation process and with *dead storage* used in storing historical files. The last criteria, *enhanced performance*, judges the potential for office system development incorporating technological advances to upgrade both the *capacity* and the *services* offered by the

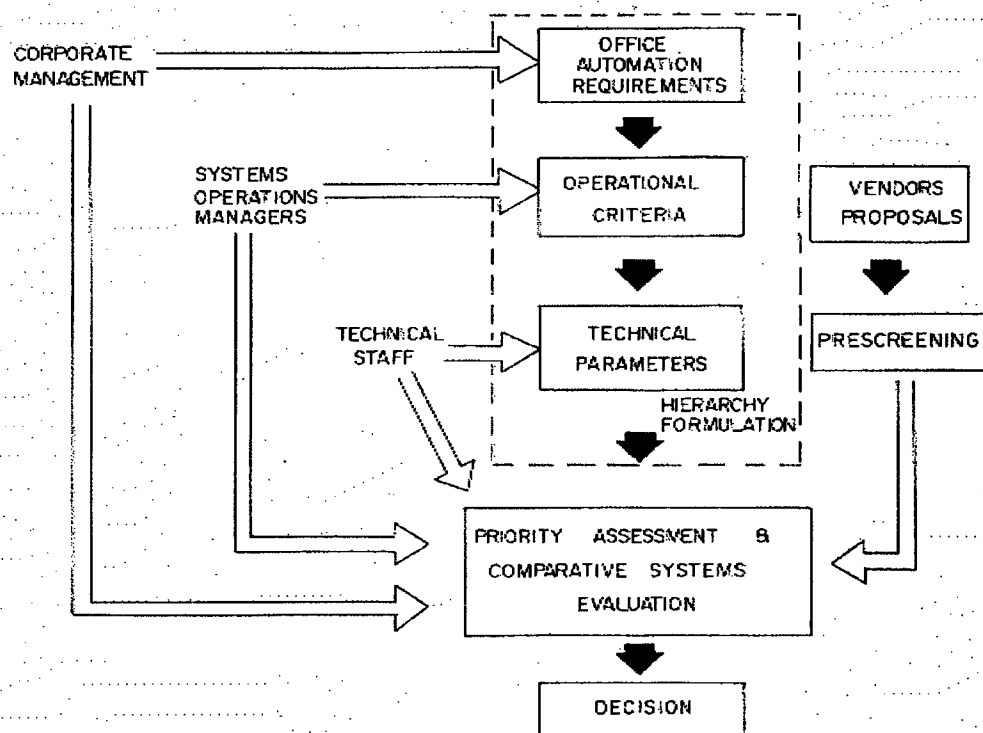


FIG. 2. The planning process.

system. These criteria, used in describing the attainment of corporate requirements, are evaluated based on technical parameters appearing on the third level. These parameters are partitioned into two groups. The first group deals with the present capabilities of the word processing systems while the second deals with the future (dormant) options available with each system. In the first group one finds parameter sets such as: *text editor, files management, keyboard features, printer, screen, CPU, memory, hard disk and floppy disk*. The second group includes items such as: *communication capabilities, potential expandability, special features and general data processing functions*. The overall hierarchy describing the decision elements in the respective levels and their interconnections is shown in Fig. 3.

Examining the hierarchy, a few observations can be made. It is composed of four levels, where each level supports elements at the level immediately above it through the relevant intercommunication. A particular element in one level may not be relevant in considering an element in a level above it. For example, the group of parameters describing the *text editor*

are relevant to the *data entry* criteria but irrelevant to the *active and dead storage* criteria. Similarly, the *ergonomics* criteria is relevant, and rather important, with respect to the productivity requirements but irrelevant to the *information management* criteria. These interconnections are flexible in the sense that they describe a particular operating environment and can be modified to reflect another [3].

Referring to Fig. 3, one observes that each member of the *technical parameter* level is made up of a number of distinct parameters. In the case of text editor, for example, the parameters include such items as *scrolling, cursor control, super copy, format repertoire, equations entries and tables*. These are general capabilities found in most editors but whose importance may vary from one installation to another. While one environment may emphasize mathematical typing (e.g. equations), another may be concerned with report generation involving, mainly, text and tables [5]. The specific parameters shown in Fig. 3 are self-explanatory and further discussion is omitted. The reader interested in the detailed description of these features and capabilities may refer to [22, 24, 36] and to the

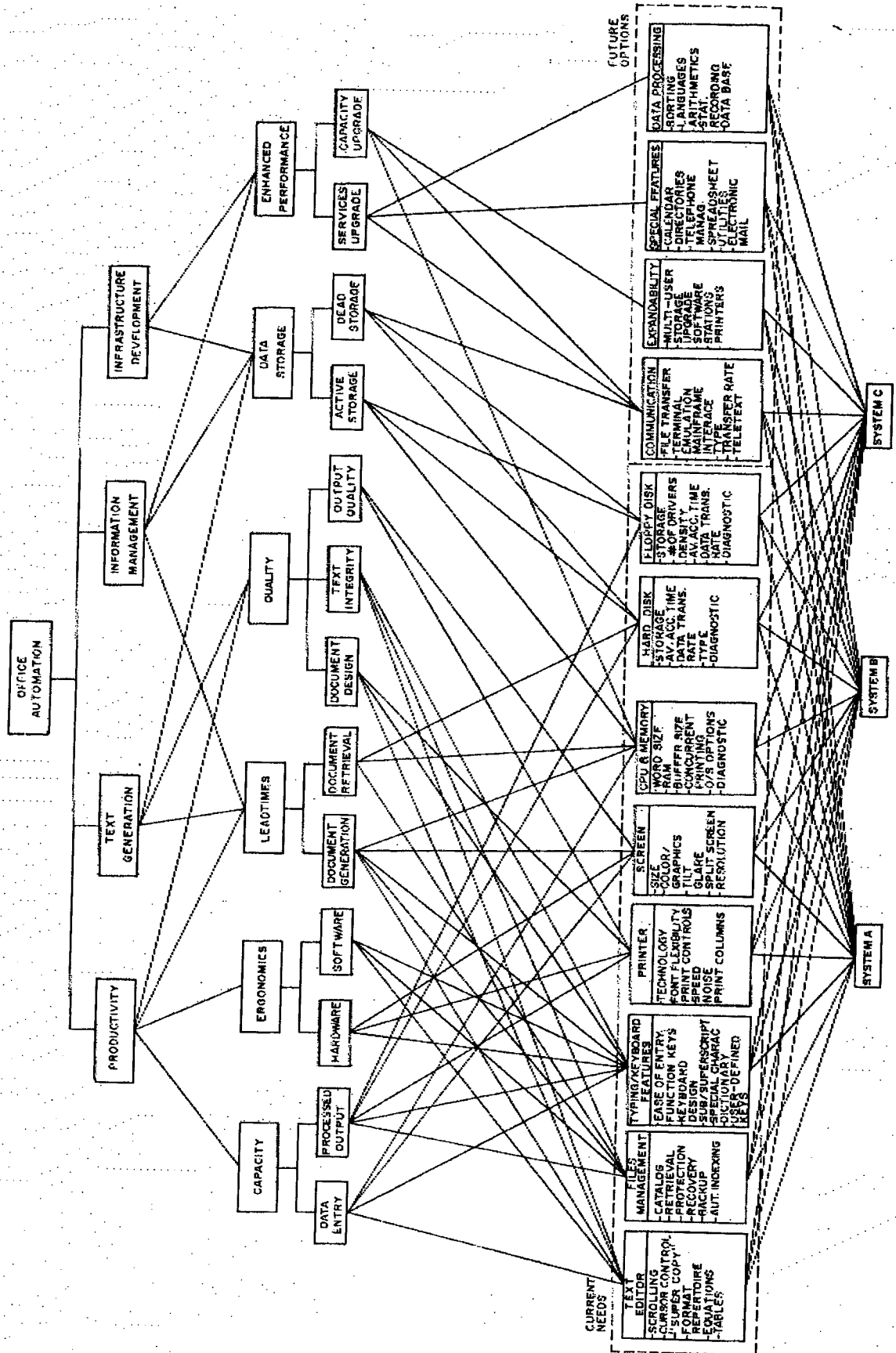


FIG. 3. Office automation hierarchy.

TABLE 2. PARAMETERS

(a) CURRENT NEEDS' PARAMETERS

Text editor:

scrolling; cursor control; 'super-copy'; format repertoire; equations; tables.

Files management:

catalog; retrieval; protection; recovery; backup; automatic indexing.

Typing, keyboard features:

ease of entry; function keys; keyboard design; sub/superscripts; special characters; dictionary; user-defined keys.

Printer:

technology; font flexibility; print controls; speed; noise; print columns.

Screen:

size; colour; graphics; tilt; glare; split screen; resolution.

CPU and memory:

word size; RAM; buffer size; concurrent printing; o/s options; diagnostic.

Hard disk:

storage; average access time; data transfer rate; type; diagnostics.

Floppy disk:

storage; number of drives; density; average access time; data transfer rate; diagnostics.

(b) FUTURE OPTIONS' PARAMETERS

Communication:

file transfer; terminal emulation; mainframe interface; type; transfer rate; teletext.

Expandability:

multi-user; storage upgrade; software; stations; printers.

Special features:

calendar; directories; telephone management; spreadsheet; utilities; electronic mail.

Data processing:

sorting; languages; arithmetics; statistical recording; data base.

technical information supplies by the vendors. For convenience, the third level technical parameters are summarized in Table 2.

The analysis framework established in this section is used next in the determination of priorities associated with the hierarchical elements to facilitate the selection of the most appropriate system for the organization.

4. PRIORITY ASSESSMENT

Acquisition decisions of advanced technological systems are made by considering relative performance levels of various technical parameters of these systems. The decision in favour of one particular system is typically influenced by the number of parameters in which it dominates its competitors. This practice, however, neglects to take into consideration the intensity of dominance between these parameters. In those cases where the intensity of dominance does count it is usually in a form of a crude scoring system [9]. This latter approach is inappropriate since scoring is provided in a semi-arbitrary manner by considering ordinal ranking and it lacks consistency checks. Another, and more important, reason for the inadequacy of this ap-

proach is that the 'importance' weights assigned to the parameters neglect to account for the overall corporate requirements. What is needed is a systematic way of relating corporate requirements through respective operational criteria to the technical parameters in a priority setting approach. Such a priority derivation scheme is provided by the AHP.

The priority assessment framework described here has been used in a number of organizations during the planning and evaluation of computerized office systems. For obvious reasons the complete set of priorities, as determined by corporate management, is not presented here. Instead, a sketch of the prioritization scheme will be outlined in order to illustrate the complete decision process.

The prioritization starts by comparing elements in the first level and by assessing their relative contribution to the overall focus of the problem. In this particular model the initial set of comparisons contrasts productivity issues vs the text generation needs. The question asked is of the form: "which of these two requirements contributes more to the overall corporate performance?". The answer provided for this question is in a form of a scale value taken from

TABLE 3. PAIRWISE COMPARISON OF CORPORATE REQUIREMENTS

	(1)	(2)	(3)	(4)	Priorities
Productivity (1)	1	1/4	1/3	2	0.12
Text generation (2)	4	1	2	7	0.52
Information management (3)	3	1/2	1	4	0.29
Infrastructure development (4)	1/2	1/7	1/4	1	0.07
					1.00

$$\lambda_{\max} = 4.022, CI = 0.0072, CR = 0.0080.$$

Table 1. Imagine a small, rapidly-growing consulting company, where office operations are mainly concerned with the generation of various reports for customers, where a significant portion of these reports involves mathematical formulas and special characters. Word processing systems are proposed in order to alleviate the text generation difficulties and to support the information management needs. The pairwise comparison process of the four corporate requirements (level 1) might lead, therefore, to the comparison matrix shown in Table 3.

The pairwise comparisons summarized in Table 3 and the derived priority vector agreed with the earlier gross statements regarding corporate priorities. That is, text generation and information management are the most important requirements to be satisfied by the system to be procured. The consistency ratio (CR) (refer to Section 2 and to [27] for more details) indicates that the answers provided were quite consistent and no further iterations are required to improve their quality.

Next, the operational criteria are prioritized. This is done by considering relative contribution of criteria with respect to each corporate requirement. For example, the productivity requirements are assessed through four criteria (c.f. Fig. 3.) namely, capacity, ergonomics, lead

time and quality. Note that not all criteria are relevant to this particular requirement. Comparing these four criteria with respect to the word processing productivity requirement leads to the comparison matrix shown in Table 4. Tables 5 to 7 summarize the pairwise comparisons with respect to the remaining criteria.

The inputs to Tables 4 to 7 were supplied by the operations personnel familiar with both the system aspects and their potential influence on the office activity. The output of the four comparisons yielding four vectors of priorities (with respect to each of the four office automation requirements) is summarized in Table 8, where it can be seen that the 'capacity' criteria dominate all others with respect to 'productivity' and 'text generation' requirements. However, it is irrelevant with respect to the remaining two requirements ('information management' and 'infrastructure development'). Similar observations can be made regarding the other criteria in Table 8. Local priorities of criteria with respect to corporate requirements are shown in Fig. 4. These four vectors of priorities provide the 'local' contribution of the criteria with respect to each requirement. The global priorities of these criteria are arrived at by invoking the hierarchical composition rule which weighs each local priority with the priority of its respective

TABLE 4. 'CRITERIA' VS 'PRODUCTIVITY'

	(1)	(2)	(3)	(4)	Priorities
Capacity (1)	1	4	3	2	0.48
Ergonomics (2)	1/4	1	1/2	1/2	0.11
Lead time (3)	1/3	2	1	1/2	0.16
Quality (4)	1/2	2	2	1	0.25
					1.00

$$\lambda_{\max} = 4.034, CI = 0.0112, CR = 0.0124.$$

TABLE 5. 'CRITERIA' VS 'TEXT GENERATION'

	(1)	(2)	(3)	Priorities
Lead times (1)	1	1/3	1/2	0.16
Data storage (2)	3	1	2	0.54
Enhanced performance (3)	2	1/2	1	0.30
				1.00

$$\lambda_{\max} = 3.009, CI = 0.0046, CR = 0.0079.$$

TABLE 6. 'CRITERIA' VS 'INFORMATION MANAGEMENT'

	(1)	(2)	(3)	Priorities
Lead times (1)	1	1/3	1/2	0.16
Data storage (2)	3	1	2	0.54
Enhanced performance (3)	2	1/2	1	0.30
				1.00

TABLE 7. 'CRITERIA' VS 'INFRASTRUCTURE DEVELOPMENT'

	(1)	(2)	Priorities
Data storage (1)	1	4	0.80
Enhanced performance (2)	1/4	1	0.20
			1.00

$$\lambda_{\max} = 2, CI = 0.00, CR = 0.00.$$

TABLE 8. GLOBAL PRIORITIES FOR CRITERIA

Criteria	Corporate requirements (priority)				Global priorities
	Productivity (0.12)	Text generation (0.52)	Information management (0.29)	Infrastructure development (0.07)	
Capacity	0.48	0.57	0.0	0.0	0.354
Ergonomics	0.11	0.0	0.0	0.0	0.013
Lead time	0.16	0.0	0.16	0.0	0.066
Quality	0.25	0.29	0.0	0.0	0.181
Data storage	0.0	0.14	0.54	0.80	0.285
Enhanced performance	0.0	0.0	0.30	0.20	0.101
	1.00	1.00	1.00	1.00	1.00

criteria. For example, the global priority of the capacity criteria is found from the vector product given by:

$$P(\text{capacity}) = (0.48, 0.57, 0.0, 0.0) \begin{bmatrix} 0.12 \\ 0.52 \\ 0.29 \\ 0.07 \end{bmatrix} = 0.354.$$

The hierarchical composition rule is applied to the remaining five criteria to yield the global priority shown in the last column of Table 8.

Following the same procedure of first deriving the local priority vectors from comparison matrices and then using the hierarchical composition to derive the global priorities, the process continues to the next level of technical parameters. Once the global priorities for each parameter group is determined, comparison ma-

trices are used to assist in the determination of priorities of specific parameters. For example, the parameters group labelled 'hard disk' may result in a global priority of 0.1. This particular group has five members whose relative importance in this group is summarized in Table 9.

Similar comparisons are performed for all the parameter sets of the third level of the hierarchy (c.f. Fig. 3). Once that is done, direct comparisons of candidate systems with respect to each parameter are carried out. To carry out these comparisons, performance levels of candidate systems in each of the parameters have to be established. Such a determination with respect to the hard disk parameters is shown in Table 10. It should be emphasized, however, that only systems whose performance levels exceed the threshold requirements (set by the RFP) enter the direct comparison stage discussed here. Comparison is carried out with respect to each of the relevant parameters. One such comparison is shown in Table 11.

TABLE 9. HARD DISK PRIORITIES

	(1)	(2)	(3)	(4)	(5)	Priority
Storage capacity (1)	1	3	2	3	4	0.40
Average access time (2)	1/3	1	2	2	3	0.23
Data transfer rate (3)	1/2	1/2	1	2	3	0.18
Type (4)	1/3	1/2	1/2	1	2	0.12
Diagnostics (5)	1/4	1/3	1/3	1/2	1	0.07
						1.00

CI = 0.0474.

TABLE 10. SYSTEMS—HARD DISK PARAMETERS

Parameters	System A	System B	System C
Storage ¹	6.3	8.2	11.6
Average access time ²	120	70	90
Data transfer time ³	8.46	1.0	6.1
Type	5 1/4" winchester	5 1/4" winchester	8 1/2" winchester
Diagnostics	good	good	N/A

¹ M-Bytes (formatted).

² Millisecond/record.

³ M-Bits/second.

TABLE 11. PAIRWISE COMPARISONS OF 'STORAGE' PARAMETERS

	(1)	(2)	(3)	Priorities
System A(1)	1	1/2	1/4	0.14
System B(2)	2	1	1/2	0.29
System C(3)	4	2	1	0.57
				1.00

CI = 0.00.

The entries in Table 11 represent judgement of technical personnel using scale values taken from Table 1. For instance, system A and B have (formatted) storage capacity of 6.3 MB and 8.2 MB, respectively. In comparing these two systems, a scale value of 2 was entered to represent the slight advantage of system B over system A. Following the same scheme, the three candidate systems are compared with respect to each of the 70 parameters established by the model. The global priority of each system is obtained by taking the inner product of the respective local priority vectors with the global priority vectors of the parameters. This product reveals the particular system whose contribution to the overall operational requirements is the greatest.

5. INTERPRETATION OF RESULTS

The prioritization process carried out in the last section pointed to the computerized office system whose 'benefit' to the organization is the greatest. Before reaching a procurement decision several 'cost' issues should be considered as well. Typical cost parameters may include elements such as: acquisition cost [1], terms of payments, service contract, service

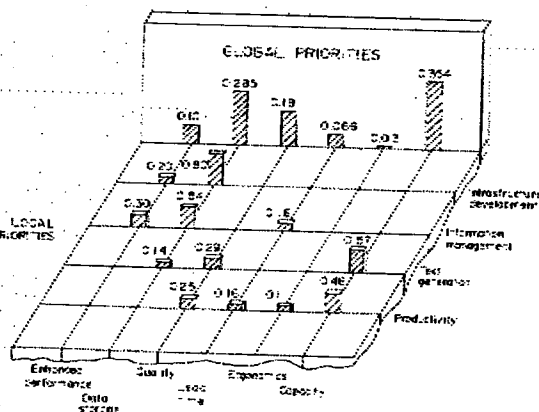


FIG. 4. Priority analysis for operational criteria.

quality [19], operational integrity, required hardware, software customizing [32] and so forth. These parameters are arranged in a hierarchy similar in structure to the one shown in Fig. 3.

The elements of the cost hierarchy are prioritized in the same manner as was done in the benefit hierarchy. That is, one starts with prioritizing the elements of the top level and progresses downward through the levels. This process results in a priority structure associated with all members of the cost hierarchy. In particular, the global priorities of elements in the last level (systems level) represent the cost priorities of the candidate systems. While the effort in the benefit hierarchy is directed towards identifying systems whose priorities are the greatest, in the cost hierarchy one looks for systems whose cost priorities are the smallest. The ideal case, of course, is to identify a single system whose benefit priority is the largest, while at the same time its cost priority is the smallest. When such ideal situations do not present themselves one uses the benefit and the cost priorities in a cost-benefit framework to determine the system to be procured [29].

Before a final acquisition decision is reached, a sensitivity analysis should be performed. This entails varying the relative importance assigned to various members of the hierarchy. In some applications, one may be interested in verifying the effect, if any, of changing the importance of infrastructure development (future design) vs current needs (c.f. Fig. 3). The sensitivity analysis examines whether such a shift in emphasis results in a shift in the priorities of criteria, parameters and therefore a different system to be selected. When no such shift is observed in the system level, one concludes that the choice is robust. Otherwise, more careful thinking has to be devoted to evaluating future aspirations vs current needs.

The hierarchical structure provided by the AHP methodology recognizes the diversity of technical, operational and organizational issues involved in a systematic approach. It lends itself to an integration effort of various levels of experience and expertise represented by management. In addition, the office automation evaluation process developed here provides a documented 'audit trail' for the explanation and presentation of results supporting the final decisions.

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