Diffusion of Transportation Planning Applications in Metropolitan Planning Organizations: Results of National Survey

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The University of North Carolina at Charlotte conducted a survey of metropolitan planning organizations (MPOs) throughout the United States to determine the extent and causes of diffusion of transportation applications in present practice. The survey quantified the current use and plans for the expanded use of these applications, documents the diffusion process, and shows how innovation is related to funding, creativity of managers and employees, agency independence, and other factors. The analysis also discusses the implications of these trends for shifts in the power structure of transportation planning. The results show that MPOs are very computer-literate, having purchased an average of eight access points for $44,000 over the past 5 years and planning even more purchases in the near future. Common hardware is IBM and IBM-compatible; commonly used software includes spreadsheets, word processors, and data base management. Specialized packages for transportation modeling are also commonly used. MPOs cite a lack of funding and computer knowledge as the key obstacles and improved agency efficiency and user demands as the key motivators to computer innovation. MPOs use primary contacts with peers and staff as the key data-gathering mode for system information. Large agencies have adopted systems 2 years earlier—on average—than other agencies, but this appears to be related to funding and knowledge constraints. No evidence was found that the characteristics of agency managers influenced the adoption of computer systems. It is concluded that rapid diffusion of computer technology through MPOs will fundamentally change the balance of power in and between planning agencies, opening up the process and encouraging cooperative technical analysis at many levels.

There are approximately 321 metropolitan planning organizations (MPOs) in the United States. Each MPO serves as the primary forum for transportation planning efforts in the area that it serves. While performing these functions, the MPO must provide leadership to, and cooperate with, city and county planning groups in its service area. The existence of these agencies is not only crucial to the structured development of an area, but also mandated by law. When an area becomes urbanized (urbanized being defined by a variety of characteristics, but all having the trait of having at least 50,000 inhabitants residing in the main population concentration), federal regulations stipulate that an MPO be formed to help manage the growth of the area.

Like many other government institutions, these MPOs in large part operate—with the exception of an occasional professional conference or workshop—in a near vacuum with regard to their peers. Little has been done to consider these organizations as a national group. Recently, the University of North Carolina at Charlotte (UNC Charlotte) surveyed the transportation activities of MPOs across the country, focusing on planning applications and software.

The university was interested primarily in the transportation planning sector of the MPOs. Often, transportation in a growing area is the first part of the infrastructure to feel pressure from the local citizens, media, and political bodies. Planning for and responding to these changes has become a data- and model-intensive prospect for any group that wishes to examine transportation patterns and growth in an urbanized area. The techniques that transportation planners use have not changed much, even though the demand for analysis has grown in response to the growth of population and commerce. Fortunately, computer technology has developed more rapidly and has kept up with the demands of the MPOs. The major problem with the new technology, or so it was theorized, was that the tight budgets of many MPOs were limiting their access to the new technology. This appears to be particularly true for the smaller organizations, which might also be hampered by another resource constraint, that of a lack of knowledgeable staff to operate the increasingly powerful models. The ultimate goal of this research was to learn more about the nature of computer technology, its use, and its growth inside MPOs across the United States.

REVIEW OF PLANNING APPLICATIONS TECHNOLOGY

The past several years have seen several studies and reports reviewing recent computer applications technology in transportation planning. TRB's Task Force on Transportation Planning Applications, initially formed to encourage dissemination of techniques, has sponsored two major conferences on this topic and plans a third conference in Dallas. The first, held in Orlando, Florida, in 1987 (*1*), focused primarily on early versions of urban transportation planning systems (UTPS) software and their applications. The second, also held in Orlando (*2*), displayed a healthy familiarity with emerging geographic information system (GIS) procedures, an expanded market penetration of UTPS-type models, and a near-universal awareness of spreadsheet-based systems. Plans for the third conference anticipate significant advances in these and other areas.

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General descriptions of software have become quite commonplace. McTrans has continued this tradition, originated by the U.S. Department of Transportation (DOT), of periodically publishing a software and systems guide; the latest, in looseleaf form, covers more than 200 commercially available and public-sector applications (*3*). McTrans's newsletter fills in during interim periods (*4*). This newsletter has recently taken over a transit-oriented service operated by Vanderbilt University. From the University of Kansas, PC Trans publishes a periodic newsletter focusing on traffic applications (*5*).

Despite the wide availability of software, surprisingly few comparative assessments of software have been published or conducted—at least for private consumption. In an early study, the New York State DOT reviewed the characteristics of about a dozen UTPS-type systems (*6*). A later assessment by Michigan described the characteristics of systems but "hid" the brand names (*7*). ITE has recently undertaken to develop a criterion checklist of software selection features, also brandless (*8*). Essentially, agencies interested in learning about software characteristics in an objective atmosphere have no readily available source. Instead, they must rely on vendor information or word of mouth.

DESCRIPTION OF SURVEY INSTRUMENT

A survey about transportation planning and computer technology was sent to all 321 MPOs in the United States. The mail-out survey was three pages long (the first page was an introduction). The following pages questioned the respondent on such topics as

- Characteristics of the MPO (size, service area),
- Functions of the MPO,
- Characteristics of computer systems and their users,
- Plans for future systems, and
- Characteristics of the manager of the MPO (years with the agency, computer expertise).

Response to the survey was considered to be quite good: nearly half (154) of the agencies responded. Ninety percent of the questionnaires were returned within 40 days after mailing. The surveys were answered with varying degrees of completeness, the vast majority being completed entirely.

The following documents the results of an analysis of data gleaned from the survey. No statistical methods more complex than standard deviations are used, but the results do show some interesting contrasts among MPOs, their staffs, and their current (and future) state of computer involvement.

FINDINGS

Size

In any discussion of the capabilities of a transportation department or MPO, the organization's size will almost invariably be brought into play: the larger the organization, generally, the more functions it serves. MPOs are thought to vary in size in a direct relationship with the size of the population that they serve. The study performed by UNC Charlotte used several indicators of MPO size: (a) population of the planning area, (b) number of employees at the MPO, and (c) the amount of funding that they received in FY 1990. Table 1 illustrates the size characteristics of the sample MPOs.

Two of the three measures presented in Table 1 vary quite widely across the sample: the size of the service population and the amount of funding. The average number of employees did not vary nearly as much. This can be seen by the standard deviation of the three variables: whereas population and funding had standard deviations that were more than two and three times greater than their means, the number of MPO employees had a standard deviation that was only half again as great as the mean. This suggests that although the assumption stated earlier, that MPO size (at least, as measured by the number of employees) follows the size of the service population, is correct, the relationship follows a fairly short logistical curve. The size of the MPO in terms of employment does not increase proportionately as the population of the service area rises.

Functions

The number of functions that the transportation department of an MPO can perform in-house—versus those that are often farmed out to consultants or other public agencies—is a measure for determining that MPOs range of capabilities. As is shown in Figure 1, not all transportation departments are equally equipped to perform some of the more infrequent or computer-intensive functions that are normally associated with such an agency. This does not mean that an MPO that must farm out much of its work ends up with worse results than a product done in-house; indeed, the opposite can be true. Figure 1 does show that transit system design and environ-

TABLE 1 Size of MPOs

RESPONDENTS	1980 POPULATION*	NO. EMPLOYEES	FUNDING, 1990
SUM	67,879,278	1,148.0	$59,171,705
AVERAGE	484,852	7.5	$402,529
STANDARD DEVIATION	1,606,562	11.1	$1,020,866

**Source:* Transportation Planning Data for Urbanized Areas

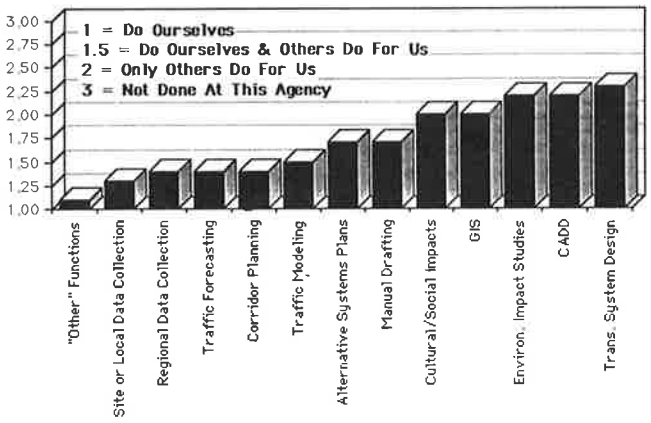

FIGURE 1 Degree of autonomy.

mental impact studies (federal EIS and EA) are performed less frequently at the MPO than data collection, corridor planning, and traffic forecasting. MPOs view the former as requiring skills that demand a higher degree of specialized knowledge or more legwork than would be practical or economical to have on hand constantly.

The various roles filled by the MPO and the emphasis each MPO places on them will necessarily affect some of these functions. All MPOs do not fulfill the same roles in every urbanized area; some are called on to do more as their skills and reputation for a certain type of project improve. All the MPOs that we surveyed said that they performed as area MPOs (Figure 2), which is to be expected. As MPOs, it is also expected that they would engage in site planning and be involved in other transportation planning efforts; about 50 percent of the respondents included these in their repertoire of functions. Traffic operations and construction of transportation facilities were activities of very few MPOs, only 17 and 2 percent, respectively. Computer technology has done more than probably any other single factor to allow smaller MPOs to perform more functions and play a larger, more diversified role in their areas.

Computers perform a variety of roles in the MPO, from the mundane, like generating a report, to the complex and power-hungry transportation modeling effort that are required of today's modern transport system analysis methods. Making all of these devices work, and work well together, produces a whole new set of problems and frustrations for the staff of an MPO. These agencies, however, would be severely crippled if not inoperable without a variety of computer systems.

One of the items that concerned the researchers was the inroads that various computer systems have made into the MPOs in recent years. Conversely, it was believed that some types of computer technology were being abandoned, such as mainframe computers. The graph in Figure 3 shows the types of systems that are being used in MPOs today. IBM and IBM-compatible machines are by far the most common type of system used, with 840 terminals being used in the 154 sample MPOs (5.5 computers per agency). However, other brand names are making a dent in the IBM dominance in microcomputing. There are 171 micros being used in the sample that are not IBM or IBM-compatible. The gap between IBM and its competitors is still quite large, but if the survey had been taken only 10 years ago, it might have been much greater. Local-area networks (LANs) have also increased. IBM mainframes and minicomputers are not nearly so numerous as their desktop counterparts. Only 70 workstations were present in the sample, and just 41 terminals for mainframes and minicomputers from companies other than IBM were recorded. The power and advantages of flexibility of microcomputers versus macrocomputers are shown clearly in Figure 3. It is very probable that within a short time, the desktop computer will compare favorably with the mainframes in power and number-crunching capability. When this happens, there will be another plunge in the use of mainframe computers that will leave only the largest and most complex of urban areas still needing mainframe capabilities.

Of course, computer technology comes at a price, and only those agencies that can allocate sufficient funds toward the acquisition of computer systems will have access to new technology. Table 2 presents the amount of spending that MPOs have concentrated on computer systems in the past 5 years, as well as the amount they expect to spend in the next 5 years. More than $6 million was spent on computer hardware and software from 1985 through 1990 in the sample of MPOs that were surveyed. The average computer expenditure is expected to increase almost two-thirds in the next 5 years ($29,474

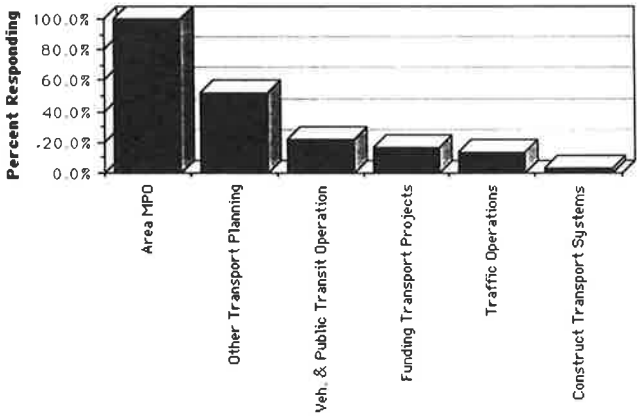

FIGURE 2 Agencies' roles in transportation planning.

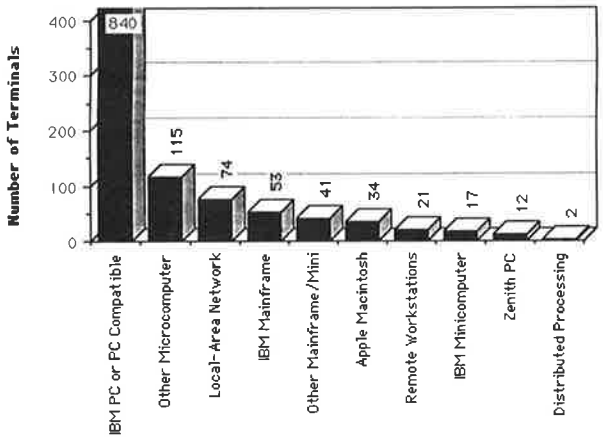

FIGURE 3 Types of systems in MPOs.

TABLE 2 Present and Future Computer Expenditures

RESPONDENTS	COMPUTER SYSTEM ALLOCATIONS	NUMBER OF ACCESS POINTS
	LAST FIVE YEARS	NOW
SUM	$6,177,900	1,136
AVERAGE	$44,128	8
	NEXT FIVE YEARS	IN FIVE YEARS
SUM	$3,713,700	1,383
AVERAGE	$29,474	10

added to $44,128). But the number of access points, a surrogate for all computer hardware (i.e., terminals, workstations, and desktop computers), will increase only by about 20 percent in the next 5 years. This indicates a relatively advanced state of commitment to computer technology in the MPOs. The majority of the initial funding was focused toward buying basic hardware, such as workstations and printers. The dramatic increase in spending will occur because future acquisitions will be geared toward acquiring more software and more efficient hardware. Both software and hardware will be bought as the needs of an expanding area population and development demand them.

What were the initial factors that contributed to some of the $6 million of MPO computer spending? What were those factors that might have hindered such spending in the past? Figures 4 and 5 address these questions. These two figures show both primary and secondary considerations when computer purchases are made.

Improving the efficiency and productivity of the MPO and its staff was the number one answer given for the primary contributing factor in computer purchases. Demands made by the staff of the MPO followed closely. Strangely, demands created by software use were the foremost secondary reason given for computer purchases. The highly touted claim of lower prices in the computer realm was not rated as high as one might have supposed.

Although increased staff computer expertise and available funding seemed to be of only moderate importance in contributing to computer purchases, these two issues were by far the greatest obstacles for most of the MPOs that were surveyed. Most of the MPO managers (93, or 60 percent) claimed that a lack of funding was the primary reason that kept their organizations from purchasing new computer systems. The second most important factor was the absence of trained computer operators. The next three most important hindering factors were obstruction by governing bodies, limited amounts of time and money available to train personnel in computer operation, and the unwillingness of top management personnel to invest in computer technology. Several of the MPOs claimed that a *loss* of productivity would result if new computer systems were installed. Compatibility with existing computer systems was seldom a hindering factor, which is some-

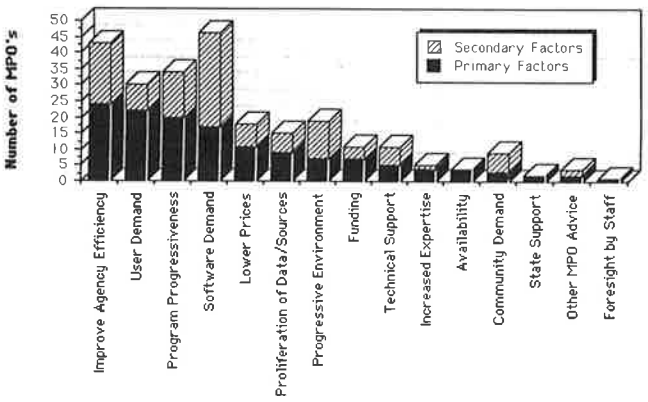

FIGURE 4 Factors contributing to computer purchasing decisions.

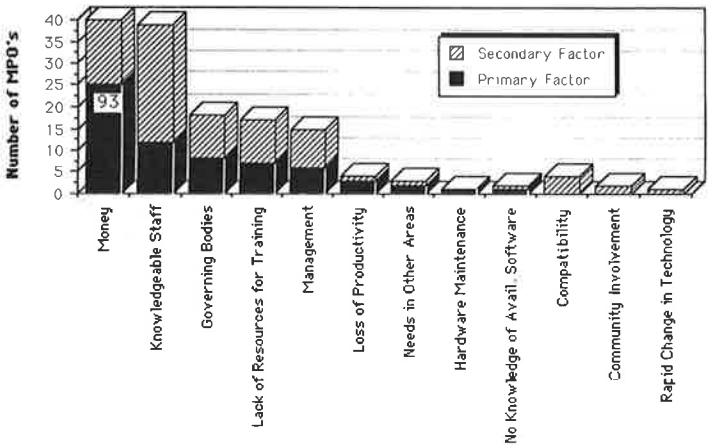

FIGURE 5 Factors hindering computer purchasing decisions.

what surprising, but it should be encouraging to those agencies considering new computer system purchases.

Figures 6, 7, and 8 show the most popular brands of the most frequent computer applications in the transportation sectors of MPOs. Word processing is the most-often-used computer application in almost any organization; competition between different manufacturers of word processors is intense. The top two word processors used by MPOs are WordPerfect and Wordstar; the former is a relatively new entry into the market, and the latter is one of the very earliest

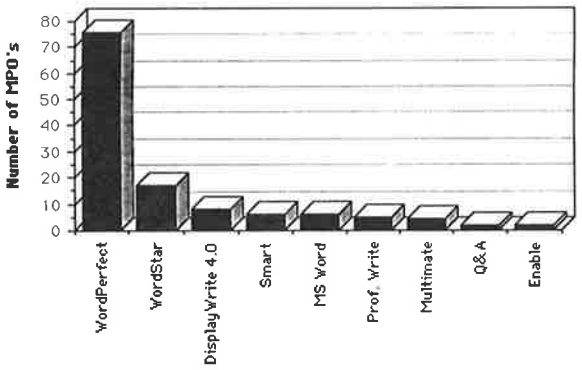

FIGURE 6 MPOs' commonly used word processors.

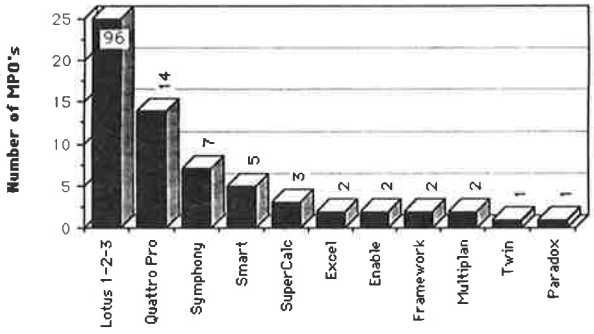

FIGURE 7 MPOs' commonly used computerized spreadsheets.

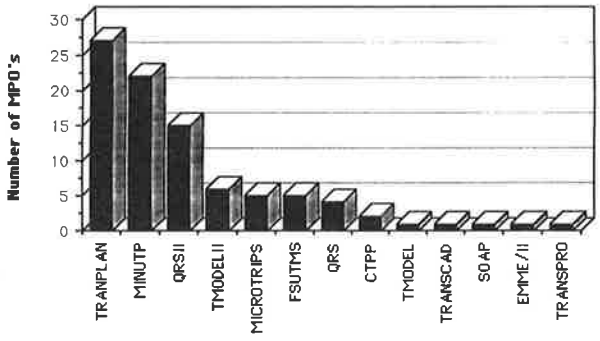

FIGURE 8 MPOs' commonly used microcomputer transport models.

word processors to achieve a wide popularity. WordPerfect is by far the more commonly used of the two, with about half of the respondents citing WordPerfect as their word processing software. Lotus 1-2-3 enjoys a similarly wide lead over its nearest competitor in the computerized spreadsheet comparison shown in Figure 7. Ninety-six of the respondents stated that they used the Lotus 1-2-3 spreadsheet. The second choice was Quattro Pro, a recent option in the field of computerized spreadsheets. Again, of these top two contenders, one is a well-established product, and the other is a new one. Unlike the situation with word processors, the older program is the more popular.

Three microcomputer-based transportation simulation models dominate the MPO markets: TRANPLAN, MINUTP, and QRS II own a commanding lead in this area over their nearest competitors, TMODEL II and MICROTRIPS (Figure 8). Earlier versions of two of these programs, QRS and TMODEL, were also given as answers. Table 3 presents the types of software found most frequently in the MPOs and the average year that they were acquired. Each software type is ranked by the number of employees that work with that software. As mentioned earlier, word processors and computerized spreadsheet programs are very popular and there are quite a few knowledgeable users in the MPO. There are an average of 7.5 employees per organization in the sample, and about 7 of these know how to use word processors and spreadsheets. Data base management, statistics, and project management programs are also used by a large percentage of the people employed at MPOs. Conversely, site-planning software and traffic-flow models are familiar to fewer employees. Interestingly, all but one of the current software programs were acquired, on average, between 1985 and 1988. UTPSs were acquired, on average, in 1977—a full 8 years before the next earliest pieces of software (either financial tracking or statistics programs, acquired in 1985). This venerable modeling tool is being replaced rapidly by the microcomputer-based systems mentioned earlier.

Many issues should be resolved both before and after the purchase of new computer hardware or software systems. Often, the effective resolution of these issues means more to their MPOs than the specific type of software or hardware or the dollar amounts spent on them. The researchers asked MPO managers how well they believed their organization was performing on specific issues relating to their computer systems. Two of these issues—operating and training personnel to operate new systems and financing needed improvements or updates in computer applications—were repeatedly ranked quite low by the surveyed MPOs (Figure 9). Again, the issue of acquiring funding is seen to be a source of frustration for those who know that computer technology is important to their organizations. Further, it suggests that more attention should be given to training personnel and to finding innovative ways of financing new technology. Identifying and priority ranking computer needs was not seen to be a problem for many of the MPOs, nor were they dissatisfied with their overall performance in developing computer applications. Some dissatisfaction was apparent with the way in which older, outdated systems are replaced or updated.

Another item that influences the decision-making process in public (and private) agencies is how information about various computer systems is gathered. Other agencies, liter-

TABLE 3 Description of Software Used by Transportation Division in MPOs

SOFTWARE SYSTEMS	AVG. YEAR OF ACQUISITION	AVG. NUMBER OF USERS	% MENTIONING (PENETRATION)
SPREADSHEET	1986	7.0	89
WORD PROCESSOR	1987	6.8	83
DATABASE MANAGEMENT	1986	4.3	76
MICRO-BASED U.T.P.S.	1988	2.0	48
HIGHWAY CAPACITY MODELS	1987	2.1	45
FINANCIAL RECORDS/ACCOUNTING	1985	2.8	38
G.I.S.	1988	2.4	34
C.A.D.D.	1988	2.8	29
STATISTICS PACKAGES	1985	4.1	26
SITE PLANNING SOFTWARE	1988	1.8	23
TRAFFIC FLOW MODELS	1988	1.7	21
MAINFRAME UTPS	1977	3.3	12
PROJECT MANAGEMENT	1988	3.7	10
TRANSIT OPERATIONS	1987	2.0	9

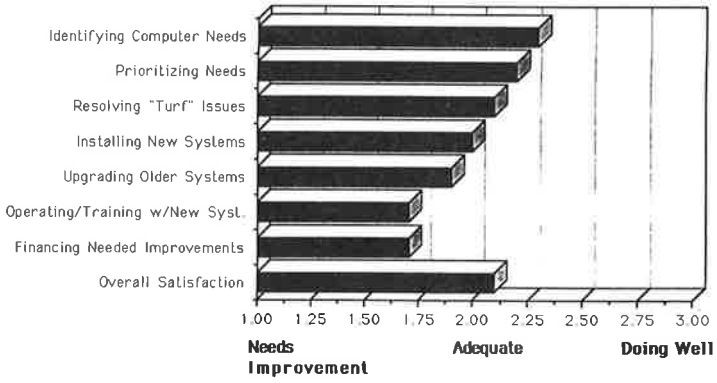

FIGURE 9 MPO performance in developing computer system applications.

ature reviews, and word-of-mouth are some traditional methods of gaining insight to computer markets. Figure 10 shows how the surveyed MPOs ranked various contacts that provide information about computer technology. Personal contacts and correspondence were ranked the most useful method of getting information about hardware and software. This was closely followed by word-of-mouth with planners and other peers, experts and agency "champions" inside their own MPO, and contacts at professional conferences. A very strong element of personal, informal contacts is a common factor with each of these methods. Four supply-side sources of information were ranked as less important to the MPOs: user groups, trade shows, consultants and vendors, and trade magazines. Since the cost of these systems is considerable, it is interesting to note that the directors of agencies put the most faith on the experiences of peers when they are getting information about new computer applications. As noted earlier, there are few comparative, up-to-date sources of such information.

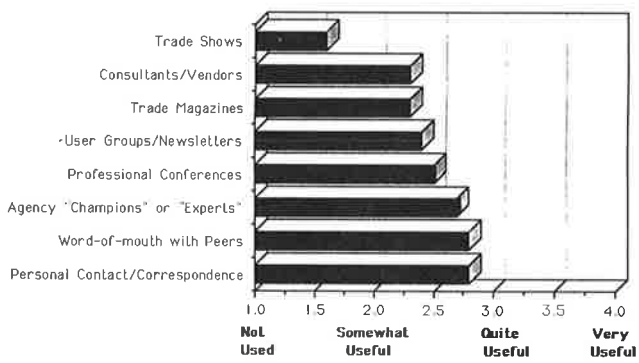

FIGURE 10 Usefulness of information sources for computer technology.

Regardless of what method the MPO used to gain knowledge about new applications, when the time came to actually purchase the new systems, the agencies responded that a formal review process was the most instrumental factor in the decision. Compatibility with existing equipment was ranked low on the list of factors hindering computer development, but it was the second most highly regarded method used in computer procurement. Similarly, a review of pertinent literature on the subject of computer hardware and software, rated low on a list of ways of getting information about new systems, ranked high in the procurement process. Only two agencies responded that no primary method was used to decide on computer purchases.

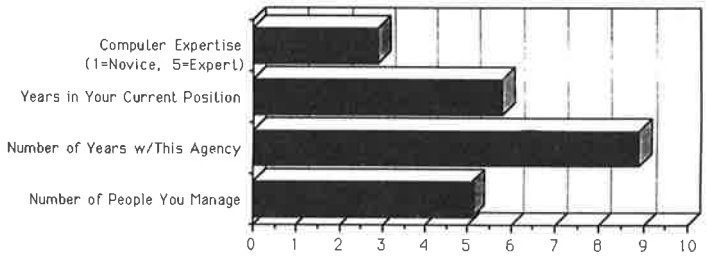

FIGURE 11 Average MPO manager characteristics.

Manager Characteristics

The manager of MPO activities will usually but not always play the most important part in decisions about computer technology. Figure 11 examines the characteristics of MPO managers. Most managers thought that they were slightly better than average in regard to computer expertise. They have spent an average of nearly 9 years with the same MPO, and more than 5.5 years in the same position in their agency. Because the average number of employees in an MPO is about 7.5, it is not surprising to see that managers supervise an average of 5 employees.

The researchers hypothesized that managers' length of employment at the same agency might negatively affect the willingness of the managers to adopt new technology quickly and the computer expertise of the managers themselves. When the managers' length of employment was cross-tabulated with these two variables, these hypotheses were found to have no support in our study sample. Less than a half-year of agency employment separated the computer novices from the computer experts. Similarly, the date of adoption of new computer systems was found to have little relevance to a manager's stay of employment at the same agency. This means either that a long-time manager varies very little in computer attitudes from a new person at the same post or that MPO managers have little to do with the actual procurement of computer systems in their agencies.

POLICY IMPLICATIONS

This study suggests a number of important policy implications for transportation planning:

1. These findings depict, in total, a remarkable diffusion of computing technology through a population of agencies in just 7 years. That diffusion is still proceeding, but the penetration rates for both hardware and software in conjunction with substantial past and planned investments show that the MPOs as a group have seized microcomputer technology with a firm grip.
2. Microcomputer software for transportation planning has now become indispensable to this trade. Its widespread use has created a de facto standard: no credible analysis can be complete without the use of such tools.
3. Rapid changes in software, particularly specialized software, can be expected to evolve further the complexity of planning. However, good transparent techniques are likely to emerge victorious.
4. Large agencies that previously held near monopolies on planning analysis can expect to see their status and power eroded. Smaller MPOs will continue to follow the lead of their larger partners, breaking dependence on mainframes and their operators. Towns and smaller counties, in turn, can be expected to develop their own analysis capabilities in parallel with their parent MPOs. With that capability will come disagreement over assessments and forecasts (stemming from different assumptions) unless agencies and analysis groups develop cooperative ways to share information and findings.
5. With planning the shift of importance from the federal government to state and local bodies in areas of hands-on activities with communities will occur. The federal government is effectively out of the modeling business, having been supplanted by the private sector. Its roles now—trainer, fund support source, and regulator—will intensify, leaving the analysis field to local governments.
6. There may be a need for promulgation of "good practice" manuals on such topics as modeling. In earlier times, such techniques were taught routinely for mainframes; now they are needed even more as the proliferation of procedures makes such practice more difficult to define.
7. Our findings roughly parallel those of an earlier study of the state highway departments (*10*) that found that agency funding was the primary deterrent to computer literacy and that larger agencies were able to adopt the technology more rapidly than smaller ones. Managers in smaller MPOs need to recognize the relationships between computer literacy and agency performance and act to ensure that their staff has the requisite equipment and skills to take advantage of these trends.
8. In the future, intensive computer use can be expected for LANs and distributed processors. But MPOs are not likely to adopt such systems in great numbers, because the nature of computing in those agencies does not require joint use of large systems planning tools. Minicomputers and workstations are not likely to replace the micro, even though the micro will become more powerful.
9. Perhaps surprisingly, a remarkable base of objective information or consumer reports was found regarding the experiences of agencies with most of these systems. There has, apparently, been no assessment of the characteristics or features of these systems. The apparent reliance of managers on word-of-mouth and agency champions in system selection is disturbing: let the buyer beware.
10. The trends in hardware appear to be toward IBM and IBM-compatible equipment, toward LANs, and away from other machines. Software trends appear to be consolidating

toward a handful of UTPS models, supported by spreadsheet and word processing systems. Students would be well advised to be familiar with these procedures. Given the investments in software training as well as data files, these locked-in behaviors will be hard to shift. Newcomers will have to offer transparent adaptability and a very significant cost or functional advantage in order to compete. GIS-based software may provide one avenue for change.

SUMMARY

The computer has changed its role in the MPO—from one of a gate that controlled doable functions to one of a conduit that expands capability. It continues to be one of the cutting edges of change in urban transportation planning, pushing out toward a more open, distributed, decentralized decision-making process. Let us hope that our institutions are up to the test. Let's make sure our software is neither Caesar's Rubicon nor Hannibal's impedimenta.

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