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MANAGEMENT SCIENCE AND INFORMATION TECHNOLOGIES IN U.S. LOCAL GOVERNMENTS: A REVIEW OF USE AND IMPACT

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Abstract—As management science and information technologies increase in importance in local governments worldwide, it is necessary to assess their evolution and impact, and to draw conclusions relevant to their future use. A historical overview of these "management technologies" is presented, along with an assessment of their current contributions and problems. Suggestions are made for their improved use in local governments both within the United States and internationally.

INTRODUCTION

OVER the past three years there have been a number of seminars and conference sessions held to assess the use of management science and information technologies in local governments. This stocktaking has been international in scope, and is continuing.† It is appropriate that this reflection on the role and impact of these technologies in local governments has come at this time. The increasing service demands, coupled with fiscal constraints, on local governments in the U.S. and other developed nations, have focused new attention on the potentials of these "management technologies" for improving the efficiency and effectiveness of local government activity. Yet, at the same time, considerable experience has been amassed with the application of these technologies in local governments, and many questions can be raised about their utility. Thus, it is now appropriate to assess what is known, and to use that knowledge to define future research agendas and direct the new and major investments that must be made in these technologies if they are to fulfill their promise.

This article presents an assessment of the evolution and status of management science and information technologies in local governments in the United States, and draws from

† As evidence of this stock-taking, a number of studies and conferences can be cited. In the area of information technology there are a number of studies that recently have been or are now being conducted to assess the current state of the art in this field: the ongoing URBIS (Urban Information Systems) Project in the United States; the LAMSAC (Local Authorities Management and Services Advisory Committee) study of computing in local authorities in the U.K.; the recently completed study of local authority computer use in nine member nations of the OECD (Organization for Economic Cooperation and Development); the joint U.S.–U.S.S.R. Study of the Application of Computers to Management of Large Cities; and the recently completed study of computing in local authorities taken on by the Council of Europe. Numerous meetings and symposia dealing with use of information technology in local authorities have been recently conducted, including: UNESCO–IBI (Intergovernmental Bureau for Informatics) international conference on Strategy and Policy for Informatics (the SPIN Conference), the Joint URISA (Urban and Regional Information Systems Association) and German Marshall Fund panel on information systems resource centers for local government; the Municipal Information Systems U.S./Japan Interchange Symposium; the 1978 Data for Development Conference on Information Systems for Development; the United Nations Conference on Science and Technology for Development in 1979; and the URISA–Kommunedata Conference on the Management of Computing.

There also has been increased cooperation between professional organizations such as the IBI, Data for Development, International Urban Technology Exchange Program, and special sections of established international organizations such as OECD, UNESCO, and the International Union of Local Authorities. In the field of management science there have been numerous recent meetings of professional associations that have featured panels dealing with application of MS to the urban sector, including the annual conferences of ORSA/TIMS (Operations Research Society of America/The Institute of Management Sciences) and the American Society for Public Administration (especially, the Management Science Section). This interest in evaluating the impacts of management science and information technology in local governments exists among both developed and developing countries; among both eastern and western nations.

this analysis conclusions relevant to their utilization by local governments in other countries.

Management science and information technologies as "package" phenomena

Management science and information technologies are not simple, monolithic entities that can be "plugged in" to urban governments. Rather, they are complex technological "packages"†. Any comprehensive assessment needs to consider the status of the various elements in these packages [1, 2]. First, there are the technical components of these technologies: computers, software, techniques, and the actual experiences urban governments have had with their use. Next, there is the broader societal infrastructure which supports development and use of these technologies. This includes national and state programs for their development, mechanisms for intergovernmental cooperation, professional networks that bind together researchers and practitioners interested in the application of these technologies in urban settings, and training and research activities that use management science and information technologies as subjects of study. In addition, the present status of management technology is only one point in an evolutionary development which has a past and, presumably, a future. The recent history of these technologies provides a perspective on how the present status was achieved. It also provides a basis for projecting the likely near-term course the field will take as a whole.

We characterize the evolution and status of management science and information technologies in local governments in terms of the "package" concept. For this reason we present first a brief overview of both management science technologies and information technologies in American local governments. This is followed by a discussion of the broader perspective on the evolution of these technologies to the present, and then by a look at what this evolution indicates about their future in local governments.

OVERVIEW OF MANAGEMENT SCIENCE TECHNOLOGIES IN AMERICAN LOCAL GOVERNMENTS

Definitional concerns

There are a number of branches of management science technologies that have been adopted and used in local governments, so some definitional attention is required to clarify the terminology. By the term "management science technology", we refer to a set of technologies that includes both operations research techniques and urban modeling and simulation. These technologies are discussed below in a "bundled" fashion; that is, we do not include separate sections for each type, but rather we review their history and current status as a class. However, there are important differences among the three in terms of the problems to which they have been applied, the support and attention they have received, and the impacts they have had. For this reason we do keep discussion of each distinct.

A brief history

The technologies of management science have seen long-term use in local governments, although growth in usage has paralleled growth in the underlying disciplines of the technologies. Simple operations research techniques have been used since the 1950s for such tasks as design of service counter facilities and staffing to reduce queues in government services [3]. Similarly, some cities have made use of these techniques to expedite traffic flow at bridges and terminals and to optimize delivery of water, gas, and electric services [4, 5]. These techniques were used primarily by the larger cities during the 1950s, since typically it was only they that had access to people with necessary management science skills and a sufficiently strong need to justify the cost and difficulty of their first application in urban settings. The 1950s also saw the birth of the first urban

† The "package" metaphor is originally from Ivan Illich's *Tools for Conviviality* (New York: Harper and Row, 1973), and has become a fundamental means of characterizing complex technologies such as information systems.

modeling and simulation efforts, which were attempts to simulate and gain understanding of the relationships between land use and transportation in large urbanized regions [6–10]. Most of these efforts were regional rather than local in scope, and in most cases financial support for them came from the federal government as part of its program for regional transportation planning.

In the early 1960s, the use of operations research techniques expanded slowly; the trained personnel needed for more rapid expansion of use simply were not available to most local governments. However, this period saw the beginning of a remarkable growth spurt in the use of modeling and simulation techniques for urban and regional planning. The major transportation-oriented modeling efforts continued to grow, and new concerns about the redevelopment of urban areas spurred growth of the first community development modeling efforts. These efforts grew rapidly, and in the mid-to-late 1960s there were dozens of major efforts aimed at modeling the dynamics of transportation, air quality, land use and development, employment, and housing [11–19]. Most of these efforts were still regional in scope, but a few had begun to focus on a single urban area, and most were supported with federal monies.

An important offshoot of these model development efforts was the creation of gaming-simulation for the training of urban administrators and planners. The METRO game, which modeled urban dynamics, was initially used for simulation of land-use decision-making [20]; with support from the Environmental Protection Agency it was later modified to include an air pollution component (becoming METRO–APEX). The Cornell Land Use Game [21], City 1 [22], and POGE [23], similarly came to be used for instructional purposes.

The late 1960s and early 1970s saw continued expansion of modeling applications to such areas as land-use planning and transportation, although by this time much of the impetus for such application had moved from the federally-funded experimental stage to the local level under local funding. In many cases categorical grant programs from agencies like the Departments of Transportation and Housing and Urban Development assisted these efforts through special allowances for information systems projects related to land use, and transportation and redevelopment planning. In a similar but more diffuse way, the use of operations research techniques began to spread among the larger local governments through an increase in availability of professionally-trained staff and/or consultants [24–27]. The large American cities formed operations research units, and the largest, New York City, had several units in the general city administration as well as in large specialized agencies such as the New York Port Authority. A significant occurrence in the operations research area was the formation in 1967 of the New York City–RAND Institute. This project, a joint venture of the City of New York and the Santa Monica-based RAND Corporation, was supported by the city and created to establish an operations research/management science in-house consulting unit that would apply techniques directly to the city's problems [28]. The institute was hailed as a major breakthrough, was mimicked by other cities, and was felt to herald the formation of a new "industry" to provide such services to local governments. These in-house and consultant efforts led to a dramatic expansion in the application of operations research techniques to new areas of government operation, such as snow removal, ambulance location, vehicle maintenance scheduling, and traffic flow optimization.

Perhaps the greatest burst of activity was in the public safety area, and it came primarily in two forms. One was the development of models for analyzing and improving the allocation of manpower and vehicles in police and other emergency services. These models, most of which were supported in development and deployment by the Law Enforcement Assistance Administration, were primarily simulations designed to optimize for certain variables (e.g. reduced response time to calls) under given constraints (e.g. number of units deployed or arrangement of beats given call for service patterns) [29–34]. The other form of application was for the location of fire stations and other public facilities. This development effort originally grew out of the New York City–RAND Institute work [35], but found its true home in Public Technology, Incor-

porated (PTI). PTI is a non-profit company established by urban public interest groups, such as the international City Management Association and the National League of Cities, to move technology into the service of local governments. PTI's Fire Station Locator System and several other facility location systems were developed and "marketed" as packages that local governments could acquire and run on their own computers [36, 37]. Most of the development and deployment effort for these systems was supported by federal mission agencies such as the Department of Housing and Urban Development, by the National Science Foundation, and by the cities' own resources.

In the mid-to-late 1970s, several significant evaluations of the experience with urban modeling and operations research techniques were made. First was the appearance of a stream of empirical research on the uses and impacts of models for planning purposes. This work, done mostly by Douglas Lee [38], Janet and Howard Pack [39–41], and Gary Brewer [42], focused attention on important questions about the utility of modeling as conceived in the urban planning and decision-making milieu. Another stream of evaluative research was carried out on operations research models, especially that by Jan Chaiken and his colleagues at RAND [43–46] and by Wright, Hall and Hatry [47], related to emergency service deployment models and facility location models for public safety. This work, while generally supportive of the efforts at development and use of operations research techniques in this sector, raised questions similar to those raised by the evaluators of the planning models.

The late 1970s saw an upswing in the application of modeling and simulation to issues in local government finance. Some of this work was built on the earlier community economic modeling, some upon earlier budgeting simulations, and some upon earlier revenue and expenditure forecasting models [48, 49]. One such effort was in the area of fiscal impact analysis where simulation models were designed to forecast the fiscal implications of alternative land development patterns. These simulation models calculate the local government revenues and expenditures that can be expected from different development patterns and indicate the relative tax efficiency of each. Frequently, they also present these calculations in the form of a municipal budget which local officials can recognize easily and understand [50, 51]. Another major effort was begun to develop independent and refined forecasting models for local government revenues and expenditures [52, 53]. Both of these efforts were subsequently spurred on by soaring inflation rates, the threat of recession, increasing reliance on federal and state grants, the taxpayer revolt, and fears of local government default. Thus, they are likely to continue throughout the eighties.

As we enter the 1980s, it is clear that the use of management science technologies by local governments is permanent and continuing. However, it also is clear that much of what has gone before has been experimental, and that the patterns of evolution in both the development and use of these technologies have been dependent largely on trial and error. Perhaps the most important discovery of the efforts to apply these technologies to the urban sector has been the recognition that the dominant variable in the use of these technologies is the organizational and community political milieu in which they are introduced [1, 2, 40, 43]. A second notable discovery has been that large, centrally-organized, federally-funded efforts to diffuse these technologies do not, in most cases, result in their widespread adoption. Instead, federally-funded efforts tend to alert local officials and professionals to the potentials of the technologies. Actual adoption and local implementation remain primarily a local decision and responsibility [44, 54, 55].

Current status: use and impact

Empirical data describing the extent to which management science technologies are used among local governments are limited, and focus mainly on a few particular techniques or packaged models. However, several generalizations can be drawn based on these data. First, a substantial number of local governments use some form of modeling or operations research. For example, the mail-out survey by Pack and Pack [39, 41] indicated that about 1500 "planning agencies" had adopted urban and regional planning

models. Of these, approximately 1050 were regional councils of government and 450 were cities and counties. Another survey, conducted by the URBIS Group [56, 57] among 713 cities and counties (cities over 50,000 and counties over 100,000 population), indicated that between 20 and 35 cities and counties used population, transportation, housing, and land-use models. The Wright, Hall and Hatry study [47] indicated that there were between 50 and 100 local government users of the PTI Fire Station Location Model (the URBIS data indicated a substantially lower number—43 users for the PTI model and all other such models combined), and Chaiken's study [43] of police manpower and vehicle allocation models showed 32 cities using them.

Second, while the current level of use of management science technologies represents progress, when taken in the context of the total population of local governments, it is clear that diffusion has only begun. For example, assuming that there are about 100 users of the fire station location models and about 100 users of the police manpower and vehicle allocation models, this represents only about 9% of the 1100 largest local governments in the U.S. (those over 50,000 in population), and less than 1% of the total number of 38,000. Similarly, if there are 450 cities and counties using planning models, this represents less than half of the 1100 largest governments.

Third, the concept of model "use" tends to be loosely defined in the studies cited. There is no accounting, for example, of those local governments that procured or built a model, ran it once or twice, and then abandoned it rather than incorporating the model into their day-to-day operations. It is likely that a substantial number of "uses" are in the former category.

The various studies indicate that, where used, management science technologies have had three major impacts. First, they have directly improved management and operations, especially where operations research models have been used in transportation, manpower and vehicle allocation, and facility location. For example, cities have reported substantial improvements in important aspects of police patrol (reduced response times, and reduced cross-beat redistribution to handle calls) without the need to increase manpower or vehicles on patrol. It is not clear whether these improvements actually make any difference in crime prevention, but they do have an effect on the quality of police services [29, 30, 45]. Similarly, fire station location analysis has reportedly had the effect of scaling-down the perceived need for new fire stations by more efficient use of existing stations or their occasional relocation [47]. There is little evidence, however, that urban planning models have had a substantive impact on urban development decisions [41].

Second, these technologies have had considerable impact on political and organizational processes within local governments. While it is expected that various political factions within local governments will attempt to use new technologies to their advantage, the extent to which political use has dominated the application of these technologies has been somewhat unexpected. Recent research on the use of fiscal impact budgeting models indicates they often are used as tools to "justify" the pro-development or anti-development position of those controlling the modeling process [50]. Fire station location models and police manpower allocation models tend to be promoted by announcing the potential political use of their outputs. That is, fire station location models can be used to "prove" that the city does not need to build more fire stations (which the fire and construction unions are promoting), while patrol manpower allocation models can be used to "demonstrate" a need for increased patrol forces to "fill the gaps" in existing patrol presence. Moreover, Pack and Pack [38, 39] concluded that the use of planning models, which produce hard numbers about potential outcomes of alternative land-use policies, increased the difficulty of reaching political consensus because the models often made more clear what there was to gain and lose, and by whom.

Finally, these technologies have had an important educational impact. Pack and Pack [38, 39] concluded that the most positive impact of planning model use was that it sensitized policy-makers to the complexity and interrelatedness of the variables in the decisions they faced, and alerted them to which variables were critical and which were

not. Similarly, the facility location models, the manpower allocation models, and the routing/transportation models have educated managers in many functional areas of local government about the dynamics of the tasks they are trying to manage and about which key elements of those tasks should be controlled [30, 43].

OVERVIEW OF INFORMATION SYSTEMS IN AMERICAN LOCAL GOVERNMENTS

There is considerably more information available about the evolution and status of information systems use by local governments than there is about local government uses of management science technologies [58, 59]. Thus, a more cogent history can be developed, and somewhat more comprehensive conclusions can be drawn about this area.

A brief history

The first electronic computer systems used in local governments were introduced in the late 1950s. These were large, batch-oriented, very expensive, and limited in capability. They were used initially only by the largest governments and were applied primarily to financial calculation and record keeping. This was a period of major experimentation with computer technology and a time of intense speculation and interest in the technology's future promise. Public officials anticipated a future in which computers would play a very major role in the operation of local governments. The information systems "package" was not yet developed (indeed, the concept of an "information system" was as yet only weakly articulated) and the acquisition and basic adaptation of computer technology was the main focus.

With the advent of mass-produced computing equipment and increased competition among manufacturers in the early and mid-1960s, the price of hardware technology dropped significantly. This, coupled with a growing interest in computer capabilities and how they might be applied to local government, led to a substantial increase in the number of large governments with computers. Urban data banks and large simulations designed to approximate emergent and future conditions in the urban environment were begun in hopes of achieving the computer's promise for local government planning [60–64], while the first research into building an "integrated municipal information system" (the IBM–New Haven Project in the city of New Haven, Connecticut) also was begun [65]. Much of this experimentation was stimulated by financial assistance from federal agencies concerned with highways and land-use planning, urban renewal and development, law enforcement, poverty and economic development, population census, employment, and social welfare. Each agency supported its own experiments with data banks, models, and simulations. The first local government information processing associations were established, and the field of "urban and regional information systems" was first articulated as a profession for teaching and research [66].

The late 1960s saw a continuing decline in the price of computer hardware and a growing pool of personnel experienced with data processing that brought further expansion in the use of computer technology among local governments. Many mid-sized governments (population 50,000–250,000) began to adopt computer systems; timesharing was first introduced on a major scale; and larger governments began to develop on-line capability for user departments. Federal government interest in exploiting the technology to its fullest resulted in creation of large programs to provide financial assistance to cities for implementing the results of earlier experiments, such as the Census Bureau's ACG/DIME program and the Department of Labor's job banks [67]. Research into integrated municipal information systems expanded and the USAC Program was first formulated and proposed to a consortium of federal agencies [59, 68]. The fragmented nature of federal government assistance for information systems in local governments thus began to be coordinated. Disillusionment with computing predictions of the early 1960s became common as the larger government users began to realize that most computerized systems

contribute small and marginal improvements rather than massive and radical improvements.

By the early 1970s, most larger governments had adopted computing, and many smaller ones were procuring computing services in one form or another. The introduction of minicomputers began a new wave of speculation about how computing might be configurated and used. Timesharing became quite common among larger governments, and sophisticated applications were operationalized. The USAC (Urban Information Systems Inter-Agency Committee) Program was underway in six cities [59]. Mild skepticism began to build about the overall value of such large experiments with the technology, but general enthusiasm for urban and regional information systems continued unabated. "Transfer" of computer applications became an increasingly popular notion, stimulated by the prospects of transferable information systems from the USAC Program and elsewhere. Large-scale funding for police computing systems and applications started to flow from the Law Enforcement Assistance Administration in an effort to create a vertically integrated and coordinated law enforcement information network [30]. Associations of information systems professionals expanded their memberships to include a wide variety of urban professions, but training and research expanded very slowly in the universities, and remained largely the effort of a few isolated individuals spread over a number of disciplines.

By the late 1970s, new technological capabilities such as minicomputing, distributed computing, and microprogramming, as well as expanded use of timesharing, brought computer technology within the reach of even the smallest governments. The large, coordinated, experimental projects of the federal government ended with the termination of USAC [69], and federal emphasis shifted to selective support for transfer of law enforcement and census applications, and to general support of local efforts through revenue sharing to improve the overall state of urban management, especially the use of financial management information systems. Most experimentation with new ways of developing and organizing information systems was carried out by cities themselves. The first large-scale study of computing policies and impacts in local government—the URBIS Project [1, 2]—took place.

Current status: use and impact

Use of computer-based information systems in U.S. local governments is pervasive. This utilization is illustrated by the extent of computer adoption and the state of computer applications development. Fifty-one percent of the local governments with a population over 10,000 now use computers, and almost all of the largest governments use computers. Use of computing is directly related to government size. The more developed users of computers—those with higher levels of investment in computing, greater sophistication of computing, a faster rate of adoption, and a larger number of computer applications operational—tend to be those governments of larger size, lower levels of industrial activity, and higher socio-economic strata. Also, the more developed users tend to be governments with a stronger professional management orientation, as measured by use of an appointed chief executive officer and professional management practices [70].

Computers are used for a remarkable variety of applications in U.S. local governments. The URBIS Project data record over 230 out of 331 possible kinds of applications in use. However, these applications are spread thinly over the population, and most current applications of computers are the automation of routine tasks such as calculating, printing, and record keeping. Only about one-fourth of the applications relate to sophisticated information processing tasks such as record-searching, record-restructuring, sophisticated analytics, and process control [71, 72].

This array of applications is spread over a variety of local government functions. Most computing applications are concerned with revenue maintenance activities (tax assessment and collection, utility billing, permit fees, general accounting), administrative "housekeeping", and police activity. In other words, most applications of computing involve activities of an administrative and social-control nature. Also, the applications

are almost all internal to the government bureaucracy. There are comparatively few applications in the areas of public information, citizen complaint handling, or provision of direct human services [73].

Impacts of urban information systems have occurred in three areas: urban service delivery, urban management, and planning and decision making.

Urban service delivery. Most citizen contacts with computerization are limited to bills for taxes and utilities and voter registration notices, so service-delivery impacts must be understood in the context of the contributions computerization makes to the functioning of service-delivery departments within the government. Computers have had a generally positive impact on the operation of local service departments, but less so than originally anticipated, particularly in terms of reducing costs. Computers have clearly aided local government operations, and will probably become more essential to those operations in the future. However, computers clearly have not reduced the cost of government operations or reduced the number of staff personnel necessary to provide services; only about one-half of the governments report such cost/staff reductions. Computerization has often generated additional information services and created a demand for expensive new data processing personnel, and even raised the costs of government operations at times. Computers have made the greatest contribution to such tasks as the processing of very large files (such as tax and utility billing operations), or direct access to centralized records by field operations (such as neighborhood health centers and wanted persons files) [2, 73].

Urban management. Information systems can help integrate governmental functions and change the working relationships between supervisors and subordinates. However, such impacts have not occurred often. In fact, the major managerial impact of information systems has been to expedite routine handling of personnel records and to provide timely reporting on budgets and expenditures [2, 73].

Planning and decision making. Information systems have impacted planning and decision making significantly. Computerization has resulted in greater availability of decision information for urban managers, along with more analytical capability for manipulating that information. Information systems have brought decision making benefits, but fewer than the full potential. Sophisticated and advanced planning and decision aids are rare in local governments, but the computer's role in analysis, forecasting, and decision support will probably be of greater value in the future [1, 2, 73].

The single best indicator of the present status of information systems in U.S. urban management is an indirect measure—the fact that local governments have almost universally adopted the technology. Clearly, computer-based information systems have proven sufficiently beneficial to warrant widespread adoption and confidence, even if the impacts have been less positive than anticipated.

GENERALIZATIONS ABOUT BOTH EVOLUTIONARY PATTERNS

Many of the directions taken in the evolution of management science and information technologies can be viewed as the result of two broad streams of initiatives—one local, the other national. The actual adoption of both management science and information technology by local governments has been primarily a local phenomenon. Most governments have adopted these technologies on their own, using their own financial resources. Their use by local governments has emphasized local priorities, evolving from routine, stand-alone, "housekeeping" applications (e.g. payroll systems; traffic control analysis) to more advanced applications servicing planning and management (e.g. fiscal impact budgeting systems; budget monitoring systems). Local governments have formed their own networks for communication with one another, although these networks as yet are limited primarily to communication among staff professionals such as data processing managers or operations analysts.

Although the federal role in the development and diffusion of these technologies generally has been secondary to that of the local governments themselves (constituting about 10% of total investment annually in computer systems, for example), the federal government has had a major influence on stimulating new development at the margins of

the technologies' application. Federal agencies have promoted the development of advanced applications through research and development, demonstrations, experiments, and the promulgation of local innovations, with the expectation that showcase demonstrations would lead the way and other local governments would follow. The effect of these efforts clearly has been strong in stimulating interest and in broadening the scope of local applications, although it has been relatively weak in the actual transfer of specific advanced applications.

This broadening of use through advanced applications has stimulated interest in these technologies among a wide range of urban professionals as well as researchers and federal agency officials. It has contributed also to the development of an interest in management science and information systems training and research in universities. However, the relationships among the federally-induced innovations, the actual technological applications in local governments, the professional networks in the field, and the organized training and research activities in the universities are extremely fragile. This is due primarily to the fact that federal involvement is temporary, indirect, and focused on stimulating development rather than on building capacity that will continue over time. Without federal support for integrating the pieces of the management science and information systems fields, they probably will continue to exhibit slow and uncertain progress.

For both management science and information technology in local government, the next decade will be shaped considerably by both local and national influences of the past. The predominant influence will continue to be the decisions and efforts of local governments themselves, particularly in the area of how these technologies are to be used. Government size, which is a fundamental indicator of its capacity to adapt such complex technologies, will distinguish two broad patterns of future use and development.

Small local governments increasingly will adopt information technologies and simple operations research techniques for the first time. For example, almost all governments with a population over 10,000 will adopt computing in the next decade. They will follow the pattern of applications development that evolved in the larger governments, beginning with the automation of routine, record-keeping applications, primarily in the finance area, and evolving slowly into broader applications. Development of both management science and information technologies in small local governments is expected to be retarded by the limited supply of technical expertise, and problems will be encountered in efforts to speed up development through transfer programs. Larger local governments will expand their use of management science techniques and information systems into new functional areas. Most will revamp and integrate their current applications of these technologies, and will develop specialized applications for management and planning in the form of operational models, geographic-oriented data bases, and financial control systems. There will be expanded development particularly within police, finance, and planning departments, and to a lesser extent throughout government departments.

The federal push for innovation in management science and information technologies will be somewhat abated for the balance of this decade and into the next, especially with regard to information systems. Federal agencies will continue to take stock of their previous innovations' achievements, cull out the better innovations, and promote the transfer of current "proven" technology and applications among a wider array of local governments. This diminished role is influenced in part by the adoption of federal revenue sharing whereby local governments have been given increased financial resources to spend on local priorities. As a result, many federal assistance programs which provided for the development of advanced technologies have been discontinued on the assumption that local governments will make the investments themselves if they are warranted.

The changes will probably be slight in the other elements of the technological "packages". The primary means of intergovernmental coordination will continue to be information exchange in the form of professional newsletters, state-of-the-art reviews, published research, and trade magazines. However, here too, national centers could emerge as new intergovernmental coordinating mechanisms through their boards of directors, their member governments, and their field advisors. The primary professional networks

will continue to be URISA and the professional associations such as APA, ASPA, and ORSA/TIMS†; it is likely that they will continue essentially unchanged. Training will continue through efforts by individual governments, although in some instances academic "minors" in these subjects might be established within the existing academic and professional programs of public administration in universities. Research also will continue to be largely an individual effort of academics associated with teaching programs, although one or two research centers might achieve institutional status, long-term funding, permanent staff capacity, and a dedicated, highly supportive clientele.

The major wild-card factor in the near-term evolution of these technologies in local governments is the private sector. In the last few years several phenomena have come together to stimulate embryonic developments in the private sector that could have major consequences for the evolution of these technologies. In particular, the advent of the major fiscal crises of highly visible local governments (e.g. New York, Cleveland), advances in large-scale simulation and integrated systems capabilities, and advances in two important areas of computer hardware technology (small but powerful computers and advanced graphics technology), have combined to create seemingly favorable markets for new privately developed and marketed packages. These have emerged in several areas. One is in the area of fiscal impact budgeting systems (FIBS). Several private firms now market major FIBS packages, and have been making money doing so. Another is in so-called integrated financial management systems, which tie together many aspects of local government financial management into integrated subsystems (i.e. the subsystems automatically feed each other information for various purposes) that can produce extensive reports and analyses of financial activity. These systems are marketed by large accounting and financial management consulting firms, as well as by several computer mainframe manufacturers. A third area of development is in special-purpose, small-scale systems to do operations research tasks such as patrol manpower allocation. This area is not as advanced in development as others, but there is at least one patrol allocation system marketed that operates on a hand-held programmable calculator. There is also a major set of packages being marketed in the area of geoprocessing and computerized mapping for planners.

Finally, there are new private publications providing assistance to local governments in the application and management of these technologies [74]. If these private-sector developments are successful at establishing themselves, they could have a dramatic effect on the diffusion of management science and information technologies for local governments, primarily because deliberate, profit-oriented marketing efforts constitute one of the most powerful mechanisms in speeding up diffusion of innovations.

CONCLUSION

Management science and information technologies clearly are emerging as important tools of local government. Moreover, they slowly are becoming a focus of national policy, an arena for intergovernmental coordination, a new professional focus for the field of public administration, and a subject of national and international study and evolving bodies of knowledge. The past 25 years have been characterized by continuous but slow growth and development of these technologies and their use in cities and counties, and by sporadic, incremental development of policy, coordinative mechanisms, professional networks, training and research.

It also has become clear during this 25-year evolution that the impact of these technologies has been and probably will continue to be considerably less impressive than often predicted. Their impact on service delivery, urban management, planning, and decision making is primarily in the form of small, marginal contributions and will continue to be. Nevertheless, when these contributions are many and continual, they are substantial in their cumulative effects.

† The organizations are as follows: URISA (Urban and Regional Information Systems Association); APA (American Planning Association); ASPA (American Society for Public Administration); ORSA/TIMS (Operations Research Society of America/The Institute of Management Sciences).

In the next decade, what happens in local governments probably will most characterize the field as a whole, particularly as the federal government completes its shift to a more passive role in promotion of these technologies. The foregoing analyses of status and evolution indicate that the "management technology" field lacks strong institutional bases of activity other than those in local governments themselves. However, the field requires institutional bases if it is ever to achieve completeness and integrity as a field. Most important, there is a need for a concentration of resources sufficient to create centers of study and advice concerned with developing sound policy for using and managing these technologies, training professionals, conducting research, providing support to the profession, and contributing new knowledge to the field.

Three features of this experience have particular relevance for other nations and for international agencies. The first is the importance of recognizing the supporting infrastructure needed by these technologies. This infrastructure appears to be a basic requirement for development of the field rather than an embellishment. The U.S. experience indicates that central government planners and urban officials need explicitly to recognize and provide for this infrastructure to achieve even moderate success in application of the technologies.

The second feature which has relevance for other nations is recognition of the relation between the central government involvement in the field and the support infrastructure necessary for success. The U.S. experience, in which the federal government has played an important but secondary role in technological development, suggests that the lesser the central government role, the greater the need for an independent supporting infrastructure. This is primarily because multiple mechanisms are needed to bring about the coordination and communication otherwise provided by strong central government policy and involvement in the field. Thus, governments seeking to encourage expanded use of management technologies in local government without the aid of an independent infrastructure should realize that continuing strong central governmental support and direction will be required.

Third, there is a corollary to the U.S. management technology experiences on an international level. The upsurge in interest in these technologies on a worldwide basis has resulted in many organizations taking the initiative to develop programs to exchange information and experiences internationally. As yet, these efforts remain fragmented, and it is likely that they will continue to be fragmented until the larger management science and information technology "packages" evolve sufficiently. However, before there can be meaningful exchange on a cross-national basis, all four elements of the package must be understood by international participants in the exchange. The various approaches to use of the technologies and the individual nations' experiences with the technologies must be documented. The approaches of central governments to assistance of local development efforts must be analyzed. Professional networks, now developing loosely through various organizations, must become established and continuing, and capable of enhancing international communication through publications, conferences, and newsletters. Finally, an established field of training and research in these technologies must be developed, and expanded internationally through exchanges of academic and professional personnel in universities and other research or training centers. Without development of these components of the technological package, the best that can be accomplished internationally is a loose confederation of professional associations from various countries, and occasional international convocations.

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