GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 3/28/80

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Project Director: R. L. Collins

Sponsor: Georgia Department of Community Affairs

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Library, Technical Reports Section
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Project Files (OCA)
Project Code (GTRI)
Other

Defense Priority Rating: N/A

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SPONSORED PROJECT TERMINATION SHEET

Date  3/23/82

Project Title: A Program of Technical Assistance to the City of Rome, GA in the Area of Productivity Measurement
Project No: B-543
Project Director: R. L. Collins
Sponsor: Ga. Dept. of Comm. Affairs

Effective Termination Date: 5/29/81
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Grant/Contract Closeout Actions Remaining:

☒ Final Invoice closing documents
☐ Final Fiscal Report
☒ Final Report of Inventions (if positive)
☐ Govt. Property Inventory & Related Certificate
☐ Classified Material Certificate
☐ Other

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FORM OCA 10:781
PRODUCTIVITY MEASUREMENT
FOR LOCAL GOVERNMENT SERVICES

INTER-UNIVERSITY TASK FORCE
GEORGIA INNOVATION GROUP OF THE
NATIONAL SCIENCE FOUNDATION

Georgia Department of Community Affairs
Georgia Municipal Association
Georgia Institute of Technology
Georgia State University
University of Georgia
Association County Commissioners of Georgia

GEORGIA INSTITUTE OF TECHNOLOGY
A Unit of the University System of Georgia
Engineering Experiment Station
Atlanta, Georgia 30332

1981
PRODUCTIVITY MEASUREMENT
FOR LOCAL GOVERNMENT SERVICES

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Inter-University Task Force
A Georgia Innovation Group
of the National Science Foundation

October 1981
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Exhibits
The U. S. economy has, in the past, consistently led the world in productivity growth. This situation has changed dramatically, however, in recent years, with the U. S. now last among the major industrialized nations in the rate of productivity growth. This decline in productivity growth has helped fire the soaring inflation rates damaging our economy over the last decade.

Concern about productivity has by no means been limited to the private sector. At the same time that productivity has slowed, the size of government at all levels has grown at record pace. In Georgia, for example, approximately 20 percent of all employees in the state are currently on public payrolls. Increases in revenues have not always kept pace with these increases in the government payroll or with increased demands for services on the part of the public. As a result, many local governments find themselves in an ever-tightening squeeze between public demands and spiraling costs. In response to these pressures, more and more local government officials are looking for ways to improve the productivity of government service delivery. This guide is designed to aid local government officials who are beginning the process of measuring and improving the productivity of government service systems.

What is Productivity?

Productivity, as it relates to local governments, refers to the quality of services provided and the relationship between those services and the resources required to produce them. For example, the productivity of a city function like sewage treatment refers both to the adequacy of the service provided for citizens and to how efficiently city resources have been used to provide the service. The productivity of a city government can also be described as the extent to which the city provides for the needs of its citizens while minimizing the costs of providing for those needs.

The Importance of Productivity Measurement

Perhaps the most important element in developing a program to maximize productivity is developing accurate measures of productivity. While
this sort of measurement is essential to healthy productivity, surprisingly few local governments actually have and use measures that adequately reflect the productivity of their activities. Many local governments do maintain information on the quantity of workload accomplished (e.g., the number of citizens served) and dollar expenditures, but this information is usually available only on a departmental or agency basis, and is inadequate for measuring productivity.

Measures of productivity are useful in a variety of contexts, including managing day-to-day operations, planning and budgeting, and program evaluation. Developing measures of productivity can itself reveal areas in which productivity can be readily improved. Furthermore, the availability of productivity measures makes it possible to assess the impact of changing or implementing programs to improve productivity over a period of time. These programs, in their various aspects, may consist of or involve organizational changes, staffing patterns, motivational programs, technological applications, the redesign of work systems, and a variety of other considerations. Without adequate measures of productivity, the impact of programs such as these cannot be assessed and reasonable decisions cannot be made about their cost effectiveness.

Purpose of the Handbook

The purpose of this handbook is to provide in a succinct format the basic principles of productivity measurement, a methodology for developing productivity measures, and an illustration of the development of productivity measures in Douglas, Georgia. The principles of productivity measurement described here are applicable to any local government entity. For the purpose of simplicity, however, the report will focus on productivity measurement in city government.

In developing and implementing the measures in Douglas and in preparing this handbook, a major consideration was the desire to develop an approach to productivity measurement that can be implemented at minimal cost and effort. It is anticipated that most local governments using the handbook will be medium-sized or small. Consequently, it was also assumed that they will not have the resources and personnel to implement elaborate measures, such as
observation systems, and that their needs would be best served by measures that can work without elaborate management systems to ensure that they are carried out. As a result, many of the measures adopted are less than ideal from a theoretical perspective. On the other hand, their simplicity increases the likelihood of their being put to use.
Government and Private Sector Productivity Measurement

It is commonly thought that the measurement of productivity is fundamentally different in government organizations than it is in private sector businesses. Businesses are presumably measured (and motivated) by the "bottom line," while profit considerations are nonexistent in government. A second difference often cited is that governments typically provide services rather than tangible products and that the delivery of services is difficult or impossible to measure. While these views, in some cases, represent valid observations about the nature of government and private sector organizations, they in no way preclude the ability to define and measure productivity in local government.

The issues involved in measuring productivity are the same regardless of whether a specific organization is designed to yield a profit or not. The net profit generated by a private sector firm gives some information about productivity, but this single index cannot stand alone as an adequate or appropriate measure. For example, a labor force may greatly increase the amount of goods it generates, only to have an unexpected softening of the market or the introduction of a competitive product reduce profits. Measuring productivity requires addressing many aspects of an organization, not just a look at a single index like the "bottom line." Thus, government organizations are at no particular disadvantage in measuring productivity, even though a "bottom line" measure is not available.

The fact that local governments have service functions and do not produce tangible products is also insufficient to suggest fundamental differences in productivity measurement between the public and private sectors. Currently, approximately 7 of every 10 American workers in the private sector are engaged in providing services rather than tangible goods. Thus, the issues facing local government officials in measuring productivity are identical to those facing managers in the service industries that employ the majority of people in the private sector.
In summary, measuring productivity in local government involves the same fundamental processes and issues as it does in the private sector. The approach to productivity measurement described here is, in general, applicable to either public or private sector organizations, and should prove equally successful in either context.

Productivity Ecompasses Different Types of Measures

Three types of measures are involved in evaluating productivity: effectiveness measures, efficiency measures, and work load measures.

**Effectiveness Measures** assess the extent to which a city, department, or other work unit achieves its desired goals. Another way of describing effectiveness measures is to say that they assess the extent to which the city or its subunits provide the services appropriate to and desired by its citizens.

Table 1 shows some examples of effectiveness measures for selected aspects of several city departments.

<table>
<thead>
<tr>
<th>Department</th>
<th>Effectiveness Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitation</td>
<td>Percentage of streets free of litter, garbage, or debris</td>
</tr>
<tr>
<td>Recreation</td>
<td>Percentage of citizens who live within 15 minutes travel time of a city park or recreational facility</td>
</tr>
<tr>
<td>Fire</td>
<td>Percentage of fires responded to within &quot;x&quot; minutes of call or alarm</td>
</tr>
<tr>
<td>Library</td>
<td>Percentage of households rating library as satisfactory</td>
</tr>
<tr>
<td>Police</td>
<td>Percentage of stolen property subsequently recovered</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>Percentage of runs missed completely or varying from schedule by &quot;x&quot; minutes</td>
</tr>
<tr>
<td>Water Supply</td>
<td>Percentage of hydrants tested that meet pressure standards</td>
</tr>
</tbody>
</table>
While effectiveness measures indicate the extent to which service goals and objectives are met, they provide no information about the amount of resources, like manpower and money, expended to deliver the services.

**Efficiency Measures** give information about the relationship between outputs (services) provided and the inputs required to provide them. Thus, as the name implies, they measure the efficiency with which services are provided. Efficiency measures can be expressed in either of two ways:

1. **Outputs** or 2. **Inputs**

\[
\frac{\text{Outputs}}{\text{Inputs}} \quad \frac{\text{Inputs}}{\text{Outputs}}
\]

Form 1 is the more commonly used ratio and will be used throughout this report. While any number of inputs can be used to help assess productivity, the most commonly used are dollars and hours of labor. An efficiency measure which uses dollars as the unit of input would indicate the amount of services provided per dollar spent. This measure is used most often in assessing productivity efficiency, since cost of services is important in most situations requiring productivity information. It may sometimes be more appropriate to use hours of labor in efficiency measures, particularly when supervisors are obtaining information on internal labor productivity for use in day-to-day personnel management. Table 2 presents some examples of efficiency measures for selected aspects of several city governments.

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1 More extensive lists of sample measures can be found in two excellent source books on effectiveness measurement: *How Effective Are Your Community Services?* by Harry P. Hatry, Louis H. Blair, Donald M. Fisk, John M. Greiner, John R. Hall, Jr., and Philip S. Schaenman, 1977, The Urban Institute, and *Measuring the Effectiveness of Basic Municipal Services*, 1974, The Urban Institute and the International City Management Association.
Table 2

Efficiency Measures

<table>
<thead>
<tr>
<th>Department</th>
<th>Efficiency Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Supply</td>
<td>Number of gallons pumped per dollar of cost to pump</td>
</tr>
<tr>
<td>Library</td>
<td>Number of citizens using library per dollar of operational cost</td>
</tr>
<tr>
<td>Sanitation</td>
<td>Number of households served in garbage collection per employee hour of labor</td>
</tr>
<tr>
<td>Police</td>
<td>Number of arrests that survive preliminary hearings per employee year</td>
</tr>
</tbody>
</table>

Work Load Measures are simply measures of work done. They are useful in deriving effectiveness and/or efficiency measures and in other internal planning and budgeting functions. It should be noted, however, that they are not in themselves adequate measures of productivity because they do not provide information about either effectiveness or efficiency. Thus, they should not be used alone as productivity measures. It might be convenient, for example, to consider the number of tons of garbage collected as a measure of productivity within the Sanitation Department. Used alone, however, this measure is inadequate because it provides no information about the ratio of the amount of garbage collected to the amount that needed to be collected (effectiveness) or about how many hours of labor or what costs were involved in collecting it (efficiency).

Work load measures, while not adequate in themselves, are often necessary for deriving more comprehensive measures that reflect effectiveness and/or efficiency.

Table 3 indicates some examples of work load measures for selected aspects of several city departments.
### Table 3
Work Load Measures

<table>
<thead>
<tr>
<th>Department</th>
<th>Work Load Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>Fires extinguished</td>
</tr>
<tr>
<td>Sanitation</td>
<td>Tons of garbage collected</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>Number of rides</td>
</tr>
<tr>
<td>Police</td>
<td>Number of arrests</td>
</tr>
<tr>
<td>Water Supply</td>
<td>Number of gallons billed</td>
</tr>
</tbody>
</table>

**Productivity Measurement Should Include Both Effectiveness and Efficiency Considerations**

If the overall productivity of a unit of city government is to be evaluated, both effectiveness and efficiency issues have to be addressed. It is possible to have services that are effective, but not efficient. For example, a sanitation department that regularly collects all garbage by employing excessive labor may achieve the objectives of the department, but at an unacceptable cost. Similarly, a city service can be efficient without being effective. A street department, for example, might pave a new street quickly and at a minimal cost, but put it in the wrong place.

There are two general approaches to incorporating both effectiveness and efficiency information into a productivity measurement system. One is to combine the two measures by using effectiveness measures as units of output in ratio measures of efficiency (e.g., output/input). In assessing the efficiency of police services, for example, a commonly used measure is the ratio of number of arrests to dollars spent. The number of arrests, however, gives little information about the quality or effectiveness of police activities. An alternative unit of output, the number of arrests which survive preliminary hearings, does provide information about the effectiveness of police activities. When used as the numerator in the efficiency ratio, the resulting productivity measure gives information about both the effectiveness and efficiency of police activities. Similarly, an efficiency measure in a water supply function might incorporate the "number of gallons meeting EPA standards" rather than simply "number of gallons" as its output unit.
In some cases, it is not possible to incorporate all the relevant effectiveness considerations in efficiency measures. In a water supply system, for example, an efficiency measure might be the number of gallons billed per dollar of service cost. A related quality consideration is the adequacy of the pressure in the water system for the water billed. Since a system to monitor pressure on a regular basis would be costly to install, ongoing pressure information is not usually available for incorporation into the efficiency measure. In such cases, separate effectiveness or quality indices should be evaluated alongside efficiency measures so that reasonable conclusions can be derived about each. In the case of the water system, pressure readings are usually obtained periodically by testing fire hydrants. This information can be used as a parallel measure of effectiveness.

It is obviously of little benefit to improve the efficiency of a service if its effectiveness declines as a result. For example, the tons of garbage collected per hour of labor input may increase, but, at the same time, the increased pace of collection may result in more spillage and missed collections. Such an outcome would not represent an acceptable state of affairs and could be detected in parallel considerations of separate effectiveness and efficiency measures.

**No Single Productivity Measure Is Adequate**

It is very rare that a single measure will express all the productivity information concerning the delivery of a city's services. For example, different individuals with different functions within an organization have needs for different types of information. A city manager concerned with the public perception of park cleanliness may be most interested in survey information indicating the public's satisfaction with maintenance efforts, while the departmental supervisor may be more concerned with the hours of labor required to mow the grounds.

In addition, the functions at any level of responsibility within a department are typically varied and independent. In a Sanitation Department, for example, it is usually helpful to measure efficiency for garbage collection and trash collection separately, since the two functions are typically handled by different crews on different schedules using different equipment. Also, depending on the use intended for the productivity information, different input units may be appropriate, such as the dollar cost of services or the labor hours required to provide them.
Decisions about what measures to employ must reflect a number of considerations, including both the requirements of the people who are to use the measures and the effort and cost required to obtain the measures. Judgment must be used in selecting a set of measures. Too few measures yield an incomplete assessment of productivity, while too many may result in information which is costly to obtain, difficult to manage, and nearly impossible to use advantageously.

One common tendency which should be avoided is using measures simply because they are readily available. These measures are often inadequate in a number of ways. Measures should be chosen or developed on the basis of a comprehensive analysis of the needs of a government unit and the unit's effectiveness and efficiency.

Collecting and Using Productivity Data

Most local governments do not at present have formal programs of productivity measurement or improvement in effect. There are, no doubt, wide differences in the nature and amount of information available on different functions that could conceivably be incorporated into a productivity measurement system. In most cases, quantitative information is available on certain aspects of services that must be reported to federal agencies, for example, gallons of water pumped and water quality test information. Also, most accounting systems have useful information on hours worked and costs of departmental services. Usually, however, this information is available only at the departmental level, and not for specific activities or functions within a department. In most cases, data collection systems for assessing productivity will need to be instituted since the available data are limited or inadequate.

Two key considerations in developing productivity measurement systems is that measurement systems should be formalized and utilized. Formalized means that procedures, along with appropriate personnel responsibilities, should be instituted to ensure that data collection will be carried out on a routine basis. Utilized means that measures adopted should be regularly reviewed by the appropriate cognizant personnel at all organizational levels and integrated into the management system. Regardless of how well productivity is measured, the potential benefits of measurement are wasted if the information goes unused.
Evaluation of Productivity Data

Once productivity measures are developed and implemented, the data obtained must be evaluated. Three general approaches to data evaluation are available.

Comparison across time. The information obtained from effectiveness, efficiency, or combination measures for a given government unit can be compared at different points in time to determine whether productivity is improving, declining, or remaining stable. Comparing performance across time is particularly useful in that it provides a monitoring process for programs designed to improve productivity. Often, the act of measurement alone will reveal ways to improve productivity. In other cases, more formal improvement programs can be implemented, and their effects assessed over time. Programs which set goals for performance and provide incentives for improvements in productivity (a wide variety are possible) are particularly effective.

Comparison between government subunits. In some cases, productivity can be compared for different geographical service areas (e.g., subdivisions, wards, precincts, etc.) or for different facilities having the same function (e.g., pumping stations, police precinct offices, fire stations, etc.). In this case, common measures can reveal differences in productivity which can be traced to a variety of factors. These differences can provide the basis for programs designed to upgrade the productivity of the less productive units.

Comparison across jurisdictions. In some cases, it may be possible to compare productivity data from other jurisdictions. This comparison requires roughly equivalent measures for the different jurisdictions being studied. While this is potentially a valuable comparison for determining relative productivity and analyzing productivity improvement methods, it may receive only limited use in the near future. Few governments presently obtain systematic information about productivity. In those cases in which such information is obtained, specific details of the measures involved usually differ in ways that make comparison difficult or impossible. As more cities begin to collect productivity data and as standardized measures are developed and adopted, however, this type of comparison will become an increasingly valuable tool in the assessment and improvement of productivity in city governments.
DEVELOPING PRODUCTIVITY MEASURES

In city government, as in any organization, the activities of the city are composed of numerous different functions carried out by many people at many organizational levels. If the productivity of a city government as a whole or of a city department is to be assessed, it is necessary to consider the productivity of the diverse functions, activities, responsibilities, people and levels of the government. It is extremely helpful and important in dealing with this complexity to start with general measures before moving on to more specific ones. Too often, managers pinpoint a specific problem in an organization -- the performance of a particular person or group, for example -- without addressing more general issues of how that performance relates to the goals, objectives, and overall productivity of the organization. They then attempt to improve productivity by measuring and improving the performance of the subject person or group. Although this approach can result in productivity improvements, it is not the best strategy for improving overall organizational productivity. For example, if one is developing measures to assess the productivity of garbage collection and decides to measure the time it takes each shift to complete a route, this would represent productivity measurement. However, low productivity could be resulting from the fact that vehicles are not properly maintained. If it is assumed at the outset that low productivity is a result of poor performance by the collection crew, real opportunities to increase productivity may be overlooked.

Another advantage of starting with general measures is that they ensure that all measures developed serve the general goals of the selected unit being examined. It does little good to develop a performance measure if the activity under study has no impact on whether the unit's goals are achieved.

Because responsibilities become increasingly general as one moves higher in an organization, it is best to start at the top and work down when performing an analysis to develop productivity measures. Such an analysis can be made much easier by the use of a performance matrix like the one depicted in Exhibit 1.2/ The matrix has four columns which correspond to the categories of

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information needed to develop productivity measures. The rows of the matrix represent the different levels of analysis which will be considered. Level I is the most general level. Each successive lower level of analysis becomes more specific. If, for example, productivity measures are to be developed for a department in a city government, Level I of the analysis would represent the functioning of the department as a whole. Level II would correspond to the critical roles or job systems within the department. In a Police Department, for example, Level II would analyze such major departmental activities as crime prevention and criminal apprehension. Level III would then consist of the specific duties required to perform the functions described in Level II. For example, the crime prevention role would be composed of duties such as patrolling specified areas and carrying out crime prevention inspections. While this level of analysis will, in the vast majority of cases, be more than sufficient to provide an adequate measurement system, an additional level is possible. Patrolling duty, for example, can be further analyzed in terms of the specific tasks or behaviors it entails, like traveling at a specified speed for a specified percentage of the patrol period.

The number of levels to be examined will vary from case to case, but generally two to four levels adequately reflect the significant aspects of productivity. Two levels are sometimes sufficient initially to identify the major components of productivity, and in these cases it may be helpful at first to limit measurement to those levels to determine the specific areas requiring further attention. Developing measures only for these specific areas as needed can help reduce the effort involved in the program and keep initial measures to a manageable number.

At each level of analysis, three types of information are required, as the performance matrix in Exhibit 1 shows. The first of these, ACCOMPLISHMENTS, is entered in the second column of the matrix. An accomplishment is the desired overall outcome or objective of each level under analysis. For example, at Level I, the most general level of analysis, the ultimate goal, objective, or mission for a given department is the accomplishment. For the Police Department, the accomplishment can be stated as:

"A safe community in which citizens feel secure."

At each level, the accomplishment should be stated as a result or outcome,
rather than as a behavior or activity. Thus, the above example states the outcome of police activities -- "A safe community in which citizens feel secure" -- but does not specify the particular activities, like apprehending criminals, that are involved in creating that outcome.

The third column in the matrix lists the REQUIREMENTS for measurement at each level. The measurement requirements are the essential factors in terms of which the specified accomplishments are evaluated. Virtually all accomplishments can be described by three types of requirements: quality, quantity, and cost. In measuring any accomplishment, any one of these requirements or any combination of them may be relevant. The task is to determine which requirements are relevant so that a measure or measures can be developed encompassing all of the accomplishment's essential features.

Quality typically refers to the extent to which an accomplishment meets some specified standard or model. For example, in wastewater treatment, a relevant quality consideration is whether a sample of treated effluent meets EPA standards for suspended solids content.

Quality can be subdivided into three components: volume, timeliness, and rate. Volume is the appropriate component when the "number of items" is relevant but time is not: for example, the number (or percentage) of households within 15 minutes travel time of a park or recreational facility. Timeliness is the appropriate component when time, but not the "number of items," is relevant. For example, "time to response" is a very important aspect of fire fighting activities. Finally, rate is the appropriate component when both volume and time are relevant. In library services, for example, "citizens using library per month" is a rate of citizen use. In water supply, "gallons pumped per day" is a rate of water pumping. All quantitative aspects of accomplishments can be expressed in terms of volume, timeliness, and rate.

Cost is the third consideration under REQUIREMENTS. Four major categories of costs must be taken into account: labor, materials, management, and capital expenditures.

Once the accomplishments at a given level of analysis and the requirements for measuring them have been identified, it is then possible to complete the fourth column of the matrix: the measures themselves. This involves
translating the measurement requirements into quantifiable units. In many cases, more than one unit could be selected to reflect a particular dimension of requirements. For example, the volume requirement in measuring the use of library services can be quantified as either the number of persons using the library in a given time period or the number of items checked out, or the various categories (e.g., books, periodicals, films, etc.) utilized. In addition, different dimensions of measurement can be combined to render composite measures. This is frequently the case when efficiency measures are expressed as outputs per unit of inputs, such as miles of streets cleaned per $1000 of cost.

There are no set rules for selecting appropriate units, but two considerations are helpful in making a decision. The first consideration is how the measures will be used. In the case of library services, for example, if it is sufficient simply to know how many citizens use the library in a given time, a simple head count would suffice as a measurement. If, however, information is desired on the pattern of use for different items in the library, then records of use (from "check-out cards") by categories of items should be tallied.

A second consideration is the individuals to whom the measures apply. In general, a measure should assess the productivity of the persons who have control over the items being measured. For example, if the productivity of garbage collectors is being assessed, it would not be appropriate to include capital expenditures as an input since garbage collectors have no control over capital expenditures. An efficiency measure that included labor hours and materials as inputs would be appropriate.

Determining the most appropriate cost measures to serve as inputs in efficiency ratios presents some additional problems. The first concerns capital expenditures. These costs can present problems in cases in which expenditures are made at one point in time for equipment that will be used over several years. This requires adopting some formula for spreading the cost over the life of the equipment. A compounding problem occurs when capital is expended for facilities that are shared by more than one department or more than one unit within a department. This occurs quite frequently with buildings and vehicles. In this case, the costs must be distributed to the different departments or units according to some formula for determining percentage utilization.
The second general problem is similar in nature and involves assigning the costs of management salaries to different departments or departmental units. As with capital costs, some formula must be adopted for assigning management costs. This formula usually must be based on an estimated distribution of time and, as a result, can be relatively arbitrary.

While these problems can be vexing, they are insignificant in many cases. If comparisons of data are made across time, arbitrary but consistent assumptions usually have little impact on the interpretation of the data. However, if comparisons are made between cities, for example, the nature of the assumptions made in each case becomes more important.
In the City of Douglas, Georgia, productivity measures were developed in two departments. One was the Sanitation Department, which included both garbage and trash collection. The second was the water supply system of the Water and Sewer Department.

The initial step in developing these measures was to collect information -- through extensive interviews with personnel at various levels of both departments -- on the organization, functions, and operation of the selected units. From the information obtained, a performance matrix was completed like the one shown in Exhibit 1. Using this matrix, measures were developed for each of the two departments. The results are shown in Exhibits 2 and 3. Two levels of analysis were selected for each departmental unit. The analysis was begun with the most appropriate upper level in each case, the water supply system in the case of the Water and Sewer Department, and the departmental level in the case of the Sanitation Department.

**Water Supply**

The first step was to determine the desired accomplishment for Level 1 of the water supply system. This was determined to be:

"An adequate supply of water delivered to citizens free from health hazards, aesthetically acceptable, and of adequate quality for household, commercial, and industrial use."

This statement of the desired accomplishment gives the deserved outcome for the water supply system as a whole in measurable terms.

The second step was to determine the requirements for measuring that accomplishment. These are shown in the third column of Exhibit 2, and included quality, quantity, and cost requirements. A major component of the overall objective of the water supply system is to provide water which is free of health hazards. Thus, a major quality consideration is the extent to which health hazards are present in the water supplied. A second quality consideration concerns the water pressure in the water system. Finally, the quality of the water in terms of its clarity, taste, and odor are important factors of citizen satisfaction.
An important quantity consideration in water supply is the extent to which the supply of water meets the demand for it. The number of gallons of water metered for use is also a significant quantity consideration, particularly as it relates to the efficiency of operation.

Finally, the cost of providing the service is an important requirement for measuring the productivity of water supply, since it determines the charges citizens will pay for their water.

Since federal and state agencies mandate testing for a variety of water characteristics related to health concerns, information on health hazards was readily available in Douglas. Thus, the measure selected to reflect this aspect of water quality was the percentage of tests on which water quality characteristics met or exceeded the standards set by the Environmental Protection Division, Department of Natural Resources. This percentage can be determined on a monthly basis simply by dividing the number of tests on which no violations were observed by the total number of tests completed.

Two measures were selected for assessing the quality of water pressure. The first was the number of validated complaints per month concerning water pressure. A validated complaint is one which, following a departmental response, was found to result from a legitimate case of substandard pressure caused by the municipal water system (rather than a problem in the citizen's own system). The second measure selected was generated from the periodic testing by the Fire Department of water in fire hydrants. The measure was the percentage of tests on which static water pressure was found to exceed 40 pounds per square inch. This measure was designed to be collected monthly.

The last measure of quality implemented was the number of validated complaints per month concerning the clarity, odor, or taste of the water supplied. A complaint was considered valid if a departmental response determined it to be the result of a legitimate instance of inadequate quality attributable to the city water system.

The measure of water supply adequacy selected was the percentage of days per month in which water use was restricted due to failures in the water supply operations.

Finally, the selected cost measure for the water supply system was an
efficiency measure which reflected the number of gallons of water metered per $100 of cost. Costs included expenditures for labor (wages and indirect costs) and materials (like fuel, treatment chemicals, and office supplies). The use of gallons metered, rather than gallons pumped, incorporated effectiveness information in this efficiency measure. The gallons metered reflected the amount of water delivered to customers (rather than lost in distribution) and the volumes of water on which revenues (for both water and sewer) are based.

After the measures for Level I of the water supply system were completed, Level II was examined. In this case, Level II consisted of the major job systems within water supply: 1) pumping, and 2) distribution. The results of the Level II analysis are also shown in Exhibit 2.

The desired accomplishment for the pumping function was determined to be "Pumps maintained in operational condition at all times." Since demand varies and all pumps are not utilized around the clock under maximum demand conditions, it was virtually impossible to specify the demand accomplishment in terms of either number of hours of operation or the percentage of time utilized. Thus the only condition that could be specified is that the pumps be operational when needed to meet the current demand for water.

The requirements for measuring this accomplishment include both quantity and cost considerations. In view of the limitations described above on specifying the desired accomplishment, the quantity requirement is one of timeliness, that is, the pumps should be available and operational on demand. The cost consideration at this level includes the labor costs for maintaining and operating the pumps, the appropriate percentage of management time devoted to pumping, and the cost of utilities, materials, and supplies (primarily electricity costs for operating the pumps).

Based on these requirements, the measures selected for the pumping operation were: 1) the number of hours of downtime for all pumps per month, and 2) the number of gallons pumped per dollar of cost to operate the pumping system.

The desired accomplishment for the distribution system was determined to be "Distribution and billing of all water pumped excluding that used in fire fighting and system flushing." This reflects an ideal distribution system, since,
if the desired accomplishment were fully achieved, there would be no loss of water in the system and no failure to meter water distributed to customers. Of course, some deviation from this desired accomplishment is expected. A new system should be able to achieve approximately 90 percent of this goal and an older system should be able to achieve approximately 80 percent of it.

The requirements for measuring this accomplishment include quantity and cost considerations. In terms of quantity, the measure selected was:

\[
gallons \text{ metered} + \text{gallons used in fire fighting and system flushing} \over \text{number of gallons pumped}
\]

If all the water that was pumped were metered or used in fire fighting or flushing the system, this ratio would equal 1.0. If half of the water pumped were metered, it would equal 0.5.

The cost measure selected was the ratio:

\[
\frac{\text{number of gallons metered}}{\$100 \text{ of cost}}
\]

Costs consist of the labor, management costs, and the costs of utilities, fuel, materials and supplies required to operate and maintain the distribution system.

**Sanitation**

The steps followed for productivity measurement in the Sanitation Department were similar to those implemented in Water and Sewer. The results are shown in Exhibit 3. At the departmental level, the desired accomplishment was defined as "An environment free of the hazards and unpleasantness of uncollected refuse." Quantity, quality, and cost requirements for measurement were established at the departmental level.

Quality considerations were reflected in the measure of the number of validated complaints per month concerning the adequacy of sanitation services. The use of observational techniques for rating the cleanliness of the city was considered but was rejected for immediate implementation. This decision was based in large part on the need to develop more fundamental aspects of sanitation service measurement before implementing relatively sophisticated observation techniques.

The second level of analysis addressed the two major job systems within the Sanitation Department: garbage collection and trash collection, as shown in
Exhibit 3. At the outset of the project, these two job systems were structured differently and were perceived as functioning at vastly different levels of effectiveness and efficiency.

The garbage collection service consisted of twice-weekly curbside pickups of garbage on each of two set routes. Garbage collectors were paid a weekly salary regardless of the hours worked, and the number of hours they worked was determined by the time required to complete the designated routes. Since the routes were typically completed in two days, the two collections per week usually required only four days of work per week. Trash collection, however, was not scheduled according to a specified route for completion in a specified time period. Workers were paid by the hour and worked eight hours per day, five days per week.

On the recommendation of the project staff, routes were established for trash collection. Since the amounts of trash to be collected on each route vary considerably from day to day and from season to season, no expected completion times for these routes were established. However, the creation of these routes enabled a common set of productivity measures to be devised for both trash and garbage collection. Over a period of time, these measures will provide information about the relative productivity of garbage and trash collection, as well as information about the source of differences in productivity.

As Exhibit 3 shows, the desired accomplishment for garbage collection was "All garbage collected on each route on the designated days." The desired accomplishment for trash collection was "All trash collected promptly after placement at curb." The measurement requirements for both accomplishments took into account quantity, quality, and cost.

As depicted in column 4 of Exhibit 3, three measures which reflect the quantity requirements for both garbage and trash collection were developed:

1. Truckloads collected per 8 crew-hours of work.

The period of 8 hours, rather than 1 hour, was used in this measure because 8 hours constitutes one working day for the trash collectors. Also, dividing the number of truckloads by 8 hours gives a value greater than 1, which is easier to interpret than a fraction of a load per hour.

Truckloads of garbage and trash collected were selected as output
measures since the city does not own weighing facilities and cannot obtain regular weights of refuse collected. Occasional weights can be obtained from a local business and are scheduled periodically to provide sampling of average truck weights. This average truck weight can then be used to approximate the number of tons of garbage collected.

2. Number of households served per 8 crew-hours.

The number of households served was obtained from the number of routes completed each week. At the end of each week the number of routes completed during the week were tallied and multiplied by the number of houses on each route. This value was then divided by the number of crew hours worked and multiplied by 8 to render the average number of households served per 8 hours of crew time. Note that even if a given household did not have any garbage or trash to be collected, it was counted as having been served since the collection crew passed the household on its route. This measure alone, then, does not account for variations in the amount of garbage or trash to be collected on a given day or week. As a result, measure 3 was added to provide this information.

3. Truckloads per 100 households served.

This measure was obtained by dividing the number of truckloads collected each week by the number of households served per week (routes completed x households per route) and multiplying by 100. This measure was expressed per 100 households rather than per single household so that typical values would be some number greater than one, making interpretation easier.

This measure gives information on the density of garbage or trash to be collected for a given period. When used in parallel with measure 2, it gives additional information helpful in evaluating the results from that measure.

In addition to these measures common to garbage and trash collection, one other measure, also listed in Exhibit 3, was instituted for garbage collection. This was "percentage of routes completed on time," where "on time" is defined as the two days normally allotted for completing each route.

Two measures reflecting the cost requirements were also developed and
were applicable to both garbage and trash collection. These are included in Exhibit 3 and are:

1) truckloads collected per $100 of cost, and
2) households served per $100 of cost.

The costs of garbage and trash collection were obtained from departmental accounting records, and included direct and indirect labor costs, materials and supplies, fuel and maintenance costs, and supervisory labor costs. Costs were determined separately for garbage and trash collection and used to generate separate cost ratios for the two collection systems.

Quality considerations in both garbage and trash collection were reflected in a common measure, "number of validated complaints by category concerning garbage or trash collection per month per 1000 residents." Categories of complaints included spilled garbage, incomplete pickups, missed pickups, and others.

Data Sources and Procedures

To compute the various measures, it is necessary to compile the considerable amounts of information comprising them. In some cases, the information was already available, in others, recording procedures had to be instituted.

In the case of the water supply systems, almost all of the required information was routinely being gathered before the measures were even developed. However, in almost all cases, the information was not compiled in such a way that it could be utilized to monitor productivity. The development of useful productivity measures required minor procedural changes to compile information already available in most cases.

For example, routine tests for water purity were conducted and reported to the Environmental Protection Division, but no summary data over a period of time had been compiled to monitor the extent of and trends in compliance with standards. Similarly, citizen complaints concerning water pressure, clarity, odor, taste, and so on were routinely recorded. The department responded to each legitimate complaint and determined the problem and the required corrective action. However, once a complaint had been handled, no permanent
record was kept of the nature of the complaint or the action taken. In order to use this information as a measure of citizen satisfaction then, it was necessary to institute a procedure for transferring information from individual complaint records to a master log that broke down complaints by frequency and type. The resulting profile could thus be used not only to assess overall levels of complaints or satisfaction but to determine which types of complaints occurred most often. This information is valuable in determining problems with the service provided.

Two very important measures in the water supply system, the number of gallons pumped and the number of gallons metered (and billed) were already being recorded. The monthly report to the Environmental Protection Division includes an entry for the number of gallons of water pumped (and treated) for each pumping station. The number of gallons of water metered and billed to customers, of course, was available from accounting records. However, neither of these measures were being used internally to monitor the department's productivity. Thus, one crucial measure for a water supply system,

\[
\text{number of gallons metered,} \quad \frac{\text{number of gallons metered}}{\text{number of gallons pumped}}
\]

was readily obtainable with minor procedural changes, even though this measure had not been utilized previously.

The more complete measure of system efficiency which was developed,

\[
\text{gallons metered + gallons used in fire fighting and system flushing,} \quad \frac{\text{gallons metered + gallons used in fire fighting and system flushing}}{\text{gallons pumped}}
\]

was obtained by adding additional information from the Fire Department. This information included available records of the number of gallons of water used in fire fighting and additional information about the gallons of water used in flushing the distribution system which were not being kept. This required having Fire Department personnel record the number of hydrants opened for flushing, the amount of times the hydrants were opened, and the flow rate from each hydrant.

The information required about the cost of the pumping and distribution systems was also available with only minor procedural changes. The normal accounting system compiled costs in categories for the Water and Sewer Department as a whole. In order to obtain separate cost information for the pumping and distribution operation, it was necessary only for the Department
Superintendent to classify invoices submitted to the accountant with codes set up to distinguish between the two operations. Items such as labor costs, which did not require monthly invoices, were coded internally in the accounting system. The result was a separate record of costs for the two operations with minimal changes in existing procedures.

In the Sanitation Department, fewer measures were already available and consequently more recording procedures were required. As noted earlier, no predetermined routes had been established in the past for trash collection. Thus, the first requirement was the institution of these routes. Once these were established, it was then possible to count the number of household, commercial, and industrial pickups on each route. This information was necessary for the measures reflecting truckloads and cost per households served, as well as households served per day. The basic data collection sheet used for each of the garbage and trash routes is shown in Exhibit 4. At the end of each day the crew foreman reported to the department secretary the crew's start and finish times, the number of loads completed, and whether or not the route was completed. At the end of each month, the secretary compiled the various measures using the worksheet shown in Exhibit 5. Note that one category, "Route Complete," required only a check on days that the route was completed rather than a number entry. Thus, at the end of the month, the number of households served could be determined by counting the number of routes completed and multiplying by the number of households on that route. In cases where a route is begun in one month and finished in another month, an estimate is made of the percent of the route completed at the end of the month and entered on the recording sheet. The last item, the households served per $100 cost, was compiled for the two garbage routes combined and for the two trash routes combined. This item also required cost information supplied by the accounting department. This information was obtained as described above for the Water Supply System.

Measurement Frequency

In order for productivity information to be most useful, it must give current information in a manner that shows trends in productivity over time. In the present case, measures were designed for compilation on a monthly basis. This frequent display of information provides a more detailed view of produc-
tivity over time than measures compiled annually. It also facilitates the evaluation of any changes in policy, procedures, or organizational structure which are instituted to improve productivity. Finally, it provides a very useful management tool, not only for enhancing productivity, but for use in day-to-day management activities like evaluating employee performance and planning and scheduling.
Exhibit 1

PERFORMANCE MATRIX

<table>
<thead>
<tr>
<th>Level</th>
<th>Accomplishment</th>
<th>Requirements</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>
## Exhibit 2

**WATER SUPPLY**

<table>
<thead>
<tr>
<th>Level</th>
<th>Accomplishment</th>
<th>Requirements</th>
<th>Measures</th>
</tr>
</thead>
</table>
| I     | An adequate supply of water delivered to citizens free from health hazards, aesthetically acceptable, and of adequate quality for household, commercial, and industrial use. | quality quantity cost | 1. Percentage of tests meeting or exceeding EPD requirements.  
2. Number of validated complaints concerning water pressure per 1000 residents.  
3. Percentage of hydrant pressure tests on which static pressure exceeded 40 psi.  
4. Number of validated complaints concerning clarity, odor, or taste per 1000 residents.  
5. Percentage of days water use restricted because of failures in supply system.  
6. Number of gallons of water metered per $100 cost of operation. |
| II    | 1. Pumps maintained in operational condition at all times.  
2. Distribution and billing of all water pumped, excluding that used in fire fighting and system flushing. | quantity cost | 1. Number of hours of pump downtime per month.  
2. Number of gallons of water pumped per $100 dollars of cost to operate pumping system.  
1. Percentage of gallons pumped that are metered or used in fire fighting or system flushing.  
2. Number of gallons metered per $100 cost of operation. |
<table>
<thead>
<tr>
<th>Level</th>
<th>Accomplishment</th>
<th>Requirements</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>An environment free of the hazards and unpleasantness of uncollected refuse.</td>
<td>quantity quality cost</td>
<td>1. Number of validated complaints per month per 1000 citizens concerning garbage and trash collection</td>
</tr>
<tr>
<td>II</td>
<td>1. All garbage collected on each route on the designated days.</td>
<td>quantity quality cost</td>
<td>1. Truckloads collected per 8 crew-hours 2. Number of households served per 8 crew-hours 3. Truckloads collected per 100 households served 4. Percentage of routes completed on time 5. Truckloads of garbage collected per $100 of cost 6. Households served per $100 of cost 7. Number of validated complaints by category concerning garbage collection per month per 1000 residents.</td>
</tr>
<tr>
<td></td>
<td>2. All trash collected promptly after placement at curb.</td>
<td>quantity quality cost</td>
<td>1. Truckloads collected per 8 crew-hours 2. Number of households served per 8 crew-hours 3. Truckloads collected per 100 households served 4. Truckloads of trash collected per $100 of cost. 5. Households served per $100 of cost. 6. Number of validated complaints by category concerning trash collection per month per 1000 residents.</td>
</tr>
</tbody>
</table>
Exhibit 4

<table>
<thead>
<tr>
<th>DATE</th>
<th>START TIME</th>
<th>FINISH TIME</th>
<th>HOURS WKR.</th>
<th>LOADS</th>
<th>ROUTE COMPLETE</th>
<th>DATE</th>
<th>START TIME</th>
<th>FINISH TIME</th>
<th>HOURS WKR.</th>
<th>LOADS</th>
<th>ROUTE COMPLETE</th>
</tr>
</thead>
</table>
Exhibit 5

MONTHLY PRODUCTIVITY SUMMARY

1. Truckloads Per 8 Hours
   A. Number of truckloads
   B. Number of hours worked
      \[ A : B \times 8 = \]

2. Households Served Per 8 Hours
   A. Number of households on route \( \times \) number of routes completed
   B. Number of hours worked
      \[ A : B \times 8 = \]

3. Truckloads Per 100 Households
   A. Number of truckloads per completed route
   B. Number of households on route \( \times \) number of routes completed
      \[ A : B \times 100 = \]

4. Cost Per 100 Households Served
   A. Number of households on route \( \times \) number of routes completed
      (Both routes combined)
   B. Cost of service for month
      \[ A : B \times 100 = \]