



**PRODUCTIVITY IMPROVEMENT:  
SUMMARY OF FINDINGS FOR POLICE  
AND FIRE DEPARTMENTS**

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## FOREWORD

This report summarizes the productivity portion of a larger project "City Hall/University Application of Urban Research and Decision Technology through Continuing Education," funded by the Office of Education, Grant No. G00-75-02104. The project involved working with four cities — Harrisburg, Wilkes-Barre, and York in Pennsylvania, and Bridgeport, Connecticut — in the development of urban technology leading to an integrated system of program budgeting, program analysis, and productivity improvement in each of the cities.

Since the purpose of the project has been to demonstrate the practical application of productivity analysis, the approach has been to employ existing data bases and to work as much as possible through personnel in each of the project cities. This report summarizes the findings of four studies and includes the recommendations derived from the analyses. A description of the methodology employed is also included. Four technical reports describing each project in detail will also be published. The technical reports will be available to specialists interested in employing this type of analysis as well as providing a basis for comparison with analyses which may have already been conducted. The ultimate value of the project, of course, is dependent upon the extent to which the practicing cities have benefited from it and the extent to which other cities take advantage of this experience.

In addition to the authors, four research assistants; John A. Garner, Jr., Timothy King, Michael Kulig, and William R. Reemtsen were involved in data collection and analysis. Special thanks are due to the personnel in each of the operating agencies who worked with the research staff in supplying data and advice. I should especially like to acknowledge the cooperation and support of the following City officials: Bridgeport — Mayor John C. Mandanici; Joseph A. Walsh, Superintendent, Department of Police; Willard Stevane, Captain, Department of Police; Wilfred J. Walker, Inspector, Department of Police; and Joseph Tirollo, Head, Data Processing Department; Wilkes Barre — Mayor Walter W. Lisman; Joseph Kunec, Chief, Bureau of Fire; and William Gittens, Deputy Chief, Bureau of Fire; York — Mayor John D. Krout; James Hooker, Director, Department of Public Safety; George E. Kroll, Chief, Bureau of Fire; Robert Little, former Chief, Bureau of Fire; Wayne Senft, Deputy Chief, Bureau of Fire; Wayne W. Ruppert, Chief, Bureau of Police; Donald Murphy, Criminal Justice Planner.

Robert J. Mowitz  
Director

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## A. Introduction

While there has been much rhetoric about the need for productivity improvement, there have been few guidelines which officials in medium-size cities can use in the development of productivity-improvement strategies. This summary report describes how systematic statistical analysis (univariate and bivariate) can be used to improve productivity in city agencies. In particular, methods to improve productivity in the police and fire services are demonstrated, while the approach could be adapted to other local-government activities.

The strategy employed in the productivity improvement projects in the Bureaus of Fire and Police in York, Pennsylvania, the Bureau of Fire in Wilkes-Barre, Pennsylvania, and Department of Police in Bridgeport, Connecticut, was (1) to evaluate the demand for fire and police services according to the type of situation (e.g., residential fire, false alarm, auto theft, murder) as related to time and location variables to discern patterns in the demands for police and fire services and (2) to evaluate police and fire response (e.g., manpower, time, equipment levels) to demands for service.

The initial question is: Do patterns exist; and if so, what are they? Secondly: Where there are patterns; what can managers (police and fire chiefs) do to reduce the demand for services (e.g., prevent fires, deter crime) and to improve the utilization of resources in responding to these situations when they do occur? The improvement in response would improve both effectiveness and efficiency. Through more appropriate matching of resources with the demand for services, a higher

level of services can be provided and resource requirements can be reduced. This is the essence of productivity improvement.

This report begins with examples of the kinds of productivity improvements suggested by analysis of agency data files. These examples demonstrate how data analysis can be useful to agency management by providing information about actual demands for services and responses. Then follows a section which describes in detail the methodology of the study, including data management concerns and development of variables for analysis. The fourth section presents highlights of the results of the study for police and fire operations. These findings are the basis for the productivity recommendations. Four supplemental technical reports provide in-depth coverage of the data analysis and a complete list of productivity improvement recommendations for each of the four agencies studied.<sup>1</sup>

#### B. Productivity Improvement Recommendations

This project demonstrates how data can help management monitor what is being done by an agency, learn how the activities relate to the demands for service, and decide how best to allocate resources effectively and efficiently to meet the needs of the community. In some cases, the results of systematic analysis will seem obvious to the police or fire chief. The analysis provides factual documentation of patterns — or of nonpatterns —

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<sup>1</sup>The four technical reports are available from the Institute of Public Administration, The Pennsylvania State University, 211 Burrowes Building, University Park, PA 16802. The titles of the reports are: "Report on Productivity Improvement in the Bridgeport Police Department"; "Report on Productivity Improvement in the Wilkes-Barre Bureau of Fire"; "Report on Productivity Improvement in the York Bureau of Fire"; and "Report on Productivity Improvement in the York Bureau of Police".

strengthening the argument to follow a specific strategy, either to make changes or to maintain existing programs. Without such documentation of community demands for service and government-agency response, it is much more difficult to present logical arguments for the decisions of an agency manager.

The poor quality of the data in the Wilkes-Barre Bureau of Fire and in the Bridgeport Police Department precluded the development of comprehensive recommendations for productivity improvement. With useable data, however, valuable recommendations for the York Bureaus of Police and Fire and, to a lesser degree, the Bridgeport Police Department and Wilkes-Barre Bureau of Fire were forthcoming. The following specific examples of productivity-improvement recommendations come directly from the analyses in this project.

1. In York, reduce the incidence of false alarms through the modification of the existing City fire-alarm system. With false alarms accounting for 27.8 percent of the 1,048 calls for service during the period of this study, a significant quantity of Fire Bureau resources are being utilized without any contribution being made to reducing the loss of life and property due to fire. Since 261 of the 292 false alarms, 89.4 percent, originated from the City alarm system, it is necessary to look to this system as the means for reducing the incidence of false alarms. The following options should be considered; the order of presentation does not indicate a priority ranking.

- a. Elimination of the City fire-alarm system.
- b. Replacement of the existing fire-alarm system with a telephone-type fire-alarm system.
- c. Selective removal of fire-alarm boxes with a high frequency of false alarms.

d. Selective replacement of existing fire-alarm boxes which have a high frequency of false alarms with telephone-type alarms.

2. In the York Bureau of Fire, reduce the size of the initial reponse when there is a high probability that an alarm is false (e.g., reported over the City alarm system). Forty-seven percent of the false alarms reported by telephone were responded to by more than one engine, but 84.8 percent of the false alarms reported over the City alarm system were responded to by more than one engine. The pattern is similar with respect to the utilization of ladder trucks.

Since only 60 of the 388 calls for service from the City alarm system, 15.1 percent, actually involved a request for fire suppression, it is necessary to question the need to provide a large response of men and equipment when the probability of fire is low. In fact, 261 of the 388 calls for service from the City alarm system, 67.3 percent, were actually false alarms. Given this situation, it would seem more appropriate to provide a smaller initial response to assess the nature of the situation before committing substantial resources. The need for a reduced response is particularly important during the periods of high false-alarm activity. The period from mid-afternoon (1500) to early morning (0459) has the highest frequency of false alarms. Eighty percent of the alarms from the City alarm system between 2100 and midnight were false. In fact, fires represent only 12 of the 103 alarms reported over the City alarm system, 11.6 percent, during this time period.

3. In all four agencies, improve the quality of data for use by management by implementing more precise reporting and report-control procedures. In the York Bureau of Police, more precise procedures to account for how crimes and calls for service are cleared need to be



established. In the Bridgeport Police Department, a series of improvements to the data-collection and auditing procedures are recommended to strengthen the foundation for meaningful analysis. The Bureau of Fire in York should collect specific information about nonfire calls for service indicating the nature of the situation and manpower and equipment utilization. Also, the coding of property loss information must be more complete. Presently, it is impossible to determine if blank spaces on the reports mean (1) no property loss or (2) failure to report the loss. The Wilkes-Barre Bureau of Fire data were of limited utility for analysis and require standardization.

4. In York, consider the possibility of reducing the number of fire companies manned between midnight and 0859, except in the central business district. Since the central business district is the only area in which there are more calls per hour for fire suppression during these hours than during the rest of the day, the level of staffing should be maintained. In other areas of the City, fewer calls are received between midnight and 0859. By shifting personnel from morning to daytime and evening hours, more manpower would be available during the hours of high fire activity and could be used more effectively.

5. For the Bureau of Police in York, establish the objective of reducing response time to under 3 minutes for 90 percent of the emergency calls. In York, 76 percent of the calls had an average response time of 10 minutes or less and 90 percent of the calls were responded to in under 20 minutes. However, FBI statistics and the National Advisory Commission on Criminal Justice Standards and Goals (NACCJS&G) state that response time under normal conditions in an urban area should not exceed 3 minutes

for emergency calls and 20 minutes for nonemergency calls.<sup>2</sup> The Bureau of Police first should establish guidelines for classifying emergency and nonemergency situations. An audit after a one-year period could be conducted to determine whether there was an improvement in the Bureau's response times. Response times tend to increase around the hours of 0100, 0700, 1200, and 1500. Shift changeover as well as traffic situations in the City may indicate the need to explore strategies for overlapping shifts and the use of decentralized patrol units during these specific hours of the day.

6. In the York Bureau of Police and in Bridgeport, devise procedures for utilizing nonsworn personnel to handle and follow up on such activities as parking violations, family disputes, and false-alarm calls, and general administrative matters. The NACCJS&G states that a police officer's effectiveness is greatly reduced if he spends large segments of his time dealing with minor traffic citations and administrative matters.<sup>3</sup>

For example, both the York and the Bridgeport analyses indicated that approximately 50 percent of the calls for police service related to noncrime matters. However, such calls tend to utilize the time of a trained and sworn officer. For instance, approximately 32 percent of the calls for service in York are miscellaneous. Police management should review these miscellaneous and noncrime calls for service and

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<sup>2</sup>National Advisory Commission on Criminal Justice Standards and Goals, Police. (Washington, D.C.: NACCJS&G, 1973), p. 193.

<sup>3</sup>Ibid.

determine whether they require the capabilities of trained and sworn officers. In Bridgeport, the need exists to review the duties associated with the City's Police Department, primarily in the area that relates to the medical-dispatch/ambulance service. Over 10 percent of the Bridgeport police calls are related to medical matters. The question arises: Is it necessary for a police officer to respond to such calls, or would it be more effective or efficient to have another manpower source service medical calls for service and utilize police resources for more crime related tasks?

7. In York, concentrate patrol resources in specified census tracts by certain time intervals of the day. For example, theft, burglary, disorderly conduct, and vandalism calls were found to exhibit patterns of occurrence. Thefts were common in the central business district between the hours of 1500 and 2000. Burglaries were found to occur frequently in primarily business and urban residential areas of the City between the hours of 2200 and 0600. In addition, disorderly-conduct offenses were concentrated in the central business and urban residential districts of the City between 1500 and 2300. Finally, vandalism was a frequent offense in the central business and urban residential areas between 1600 and midnight.

An evaluation program could be initiated to monitor patrol effectiveness in the above specified areas of the City. For example, observations on theft, burglary, disorderly conduct, and vandalism rates could be tabulated before a program of more concentrated patrol is directed toward these areas of the City. Then, a program which increases patrol efforts in the indicated census tracts would be implemented for a specified period of time. Subsequent observations of the crime rates could be

tabulated after the initiation of the program and compared with the initial observation. This would provide some indication of the relative effectiveness of patrol strategies in regard to deterrence of crimes and apprehension of suspects.

8. In York, consider the elimination of Fire Station Number 6 as an active station and utilize the Lincoln Fire Company in conjunction with Engine 2 and Ladder B from the Vigilant Fire Company to cover calls for service in the areas of the City now covered by Station Number 6.

Engine Companies 6 (Royal Fire Company) and 9 (Lincoln Fire Company) are used primarily in census tracts in the western and northern portions of the City of York. Overall, Engine 9 responded to only 23 fires during the period of this study. However, Engine 9 is the only engine located in close proximity to the extreme northern areas of the City. On the other hand, the area along West Market Street is in close proximity to Engines 6, 9, 2, and Ladder B. Elimination of Station 6 would lead to increased utilization of Engine 9 and the risk of loss from fire would not be increased appreciably because of the close proximity of the remaining fire companies. In fact, the Vigilant Fire Company is only slightly more than four blocks from Station 6. Elimination of Station 6 as an active station would allow the Bureau of Fire to reallocate the resources for other duties.

### C. Methodology

#### Direction of the Analysis

If fire and police management is to become more productive, the relative amount of time and resources that are devoted to different

responsibilities and activities must be known. The data gathered from the agency records in this study provide sufficiently precise information to evaluate the major activities of the police and fire departments, diagnose related problems, and design more productive strategies for providing the required public services. The data also provide a measure of the relative demand for various crime, noncrime, and fire services. This analysis of the demand for fire suppression and police-patrol activities provides the foundation for a more in-depth analysis of the central issues and the contribution of sound professional judgment for interpretation of the results.

The productivity objective is to allocate men and materials to respond to situations in the most effective and efficient manner. To accomplish this objective, it is necessary to analyze the time and location of demands for service; the type of situations found; the resources utilized in providing the service; and the impacts of the service in reducing the loss of life and property from criminal, noncriminal, and fire situations. By emphasizing the actual activities of police patrol and fire suppression, management must either justify the mix of personnel and materials as it relates to stated program objectives or face the task of bringing objectives and activities in line.

#### Productivity Measurement Considerations

Defining appropriate units of measurement (outputs and impacts) for public-safety services is complex and controversial. First, it is difficult to agree on what activities should be included as outputs and impacts in relation to objectives of public services. Such "soft" measures as the level of perceived security from crimes and the degree of satisfaction

with police response to victimization incidents are difficult to use in the development of programs to improve police services, and these studies are usually very expensive.

Even more difficult to measure is the effect of crime-deterrence efforts; the number of crimes deterred or incidents avoided cannot be measured, although this is one of the most important impacts of police patrol. Even here, systematic analysis of agency records can help by highlighting high-crime areas or times of day and establishing a higher profile of officers on patrol. Evidence that the crime rate is decreasing in such cases may not prove conclusively that the police strategies are or are not effective; but a lower crime rate is the primary goal, whatever the cause. Activities which appear to be associated with a decrease in crime or increase in apprehension should be evaluated more closely to establish whether or not the relationship is valid and whether the effective strategies could be applied elsewhere.

Similar issues pertain to fire-services measurement; for example, the extent of deterrence of arson or the extent of fire prevention as a result of fire-safety-education programs is not measurable per se, but indication of a decrease in fires over time would indicate support for such deterrence activities.

In order to have available the types of information needed for analysis, the evaluative factors should be built into the program from the start. This avoids the situation of maintaining quantities of useless data, yet lacking needed information.

#### Data Management

After the measures to be used in the productivity-improvement analysis have been developed, it is necessary to collect the appropriate

data for each of the measures. The data-collection efforts could range from the retrieval of data which already have been collected by the agency to the development of new data-collection instruments. In selecting the data-collection techniques, it is necessary to weigh the quality of the data that is required, the cost of collecting the data, the time constraints, and how the data will be utilized.

Because this study relies on data already available in agency files, no elaborate collection efforts should have been necessary. However, great variation in the quality of the data was found among the four agencies studied. In Bridgeport, where the Police Department has a highly sophisticated computer operation, the computer and information-storage capabilities were not being effectively utilized. The police reporting forms were not completed, and there was a high error and missing-information rate for data entered on the computer. Police management was unaware that the data were not being collected or entered properly. For example, it was discovered that some data collection on victims and response times in Bridgeport police files was discontinued and that the most recent files for 1976 were most incomplete. When the analysis was undertaken, victimization and response-time information would have been important features to examine for possible revision of police strategies. Often, one result of an evaluation analysis is that the quality of existing data can be checked and perhaps improved.

In Wilkes-Barre, the basic data-collection instrument for the Bureau of Fire was the source of problems. It provided data that could be only marginally useful for analysis. For example, under the category, Occupancy Type, the categories were not mutually exclusive; they included grass, dump, vehicle, fence, structural, gas, wiring, and commercial establishment. A more uniform and standardized reporting system could have been used.

Although there were some problems with the data-collection instrument used by the York Bureau of Police, the major problem for both the Bureau of Police and the Bureau of Fire in York was the inability to process or analyze adequately the data in an effective manner. This was primarily due to the lack of any type of computer support.

In contrast with the Wilkes-Barre fire-reporting system, the York Bureau of Fire uses the Uniform Fire Information Reporting System (UFIRS) developed by the National Fire Protection Association, which provides standard forms and terminology for data collection. Such a uniform system allows compilation of comparable statistics from different municipalities. This can be used to form a broad data base and comparisons between cities.

Of course the reporting must be complete and accurate in order for analysis to provide valid conclusions and useful recommendations. It is a management responsibility to know what data are needed, how they will be used, and in fact whether they are being collected at all. Information on needs (calls for service) and responses by an agency is essential in order to exercise control over operations. It does not make sense to reallocate resources based on inconclusive or ambiguous data.

Even in medium-size cities the quantities of data are so overwhelming that some form of computer capability is a prerequisite to in-depth analysis. A particular requirement is for a flexible system which can be used by agency personnel. For example, the Bridgeport Police Department's sophisticated computer system is at present inflexible, limiting its usefulness to the Police Department. Their data analysis is limited to crime code by location variables; major program modifications are required to do other analysis.



This study used a widely available tool for analysis, Statistical Package for the Social Sciences (SPSS).<sup>4</sup> Although SPSS can be used with sophisticated statistical and analytical techniques, it was used here for more basic analysis, specifically addressing the needs of the fire and police services under study. The remainder of this section introduces the techniques used — univariate, bivariate, and elaboration analysis.

### Data Analysis

The real analysis of the performance, resource utilization, quality of data, and impacts of an agency's activities begins with an examination of the univariate frequency distributions. Based on the results — indicating relative demands for service, type of situations found, utilization of manpower and equipment and the impact of responses to calls for service — the manager can begin to detect incidents or patterns for further analysis. In York there was a variation in the number of fire alarms across the nine months of the study; the number of fire alarms was noticeably higher during the autumn months. This finding suggests the need to explain why there was the increase in the alarms during these months.

The need to explain the patterns found in the univariate frequency distributions leads to the next step, bivariate analysis. In this step an effort is made to determine whether there is any relationship between the pattern initially observed (e.g., increased fire alarms in the

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<sup>4</sup>For a description of the SPSS system, see Norman H. Nie, C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Brent, SPSS: Statistical Package for the Social Sciences (2nd ed.; New York: McGraw-Hill Book Company, Inc., 1975).

autumn) and other variables. In York, the increase in the number of alarms in the autumn months was found to be largely due to an increase in the number of false alarms. Given this information, the objective for productivity improvement is to develop strategies for reducing the incidence of false alarms.

The need to reduce the incidence of false alarms leads us to the next step of our analysis, which is referred to as an elaboration analysis. In the elaboration analysis, one variable is held constant; in our example, one is only interested in the incidence of false alarms. Controlling for false alarms, it is then possible to determine the specific location and time of occurrence of these false alarms. In York the analysis pointed out specific fire-alarm boxes which were likely to be used to report false alarms, especially between 2100 and midnight.

The following descriptions of classes of variables and levels of analysis are illustrated with examples from this project. First, classes of variables are introduced as they can be used in univariate analysis. This is followed by an explanation of the type of variables included in bivariate analysis. The final part of this section suggests some of the directions that elaboration analysis may take.

#### Univariate Analysis

The analysis of each class of variables for both police and fire-suppression activities begins with absolute and relative frequency distributions including relevant summary statistics. The frequency distributions report the number and percent of the incidents occurring at particular times or locations.

The univariate frequency distributions show such things as: (1) what type of fires or calls for police service are most/least frequent, (2) which areas of the City have the most/least crimes or fire alarms, (3) which fire-alarm boxes are used most/least frequently, (4) what is the range of property loss due to fire or theft, and (5) what is the range of number of units responding to police calls or fire (e.g., how often one unit responds, how often all available equipment is used). Such information provides the foundation for further analysis, as well as begins the process of suggesting priorities for increasing productivity in the future.

The variables used in the univariate analyses are divided into four broad classes: (1) Time and location variables, (2) Situation variables, (3) Resource variables, and (4) Impact variables. These four classes are then used in the development of both the bivariate analyses and the elaboration analyses.

Time and location variables. The time and location variables provide specific information about when and where the demands for service occur. As indicated above, knowledge that fire alarms increase during the autumn months eventually can lead to a specific program to reduce the incidence of false alarms.

Situation variables. In addition to knowing when and where the demands for service occur, it is also necessary to know the type of situations that were found. For example, the finding that over 10 percent of the police service calls in Bridgeport were actually for medical problems suggests that the major activities of the Police Department are not all crime-related. As such, it is necessary to consider these non-crime functions when evaluating the performance of the Police Department.

Resource variables. The resource variables indicate the quantity and type of resources that are being used in responding to calls for service. The fact that most of the fire alarms in York were not accompanied by a response from volunteer firefighters raises the question of the effective utilization of this valuable resource.

Impact variables. The impact variables provide a measure of the effectiveness of the particular fire or police activity. Analysis of the response times of the Bureau of Police in York revealed wide variations in the response time. For productivity purposes it is necessary to determine the reasons for these variations. If, as was found, the response times tended to increase during changes of shifts, there is an indication for the need to change existing procedures concerning the changing of shifts.

In this project, frequencies for fire-bureau calls for service include:

1. Time and Location
  - a. Month of call for service
  - b. Day of week
  - c. Hour of day
  - d. Census tract of call (alarm)
  - e. Census tract of fire
2. Type of Situation
  - a. Method of alarm
  - b. Type of call for service
  - c. Type and source of fire
  - d. Type of structure requiring fire suppression
3. Resource Utilization
  - a. Utilization of human resources
  - b. Utilization of equipment

4. Impact of Fire Operations
  - a. Deaths and injuries
  - b. Property loss
  - c. Response time

The data collected on police-patrol demands for service and activities parallel the fire-suppression data:

1. Time and Location
  - a. Month of call for service
  - b. Day of week
  - c. Hour of day
  - d. Census tract of call
2. Type of Situation
  - a. Crime-code classification
  - b. Clearance-code classification
3. Resource Utilization
  - a. Utilization of human resources
4. Impact of Police Services
  - a. Response time

Basically, the same method would be used in other City departments — that is, examining events according to type of situation, time and location of occurrence, and resources needed to respond. Determining appropriate measures of effectiveness of response may be difficult in some areas; nonetheless, measures should be developed to capture the impact of government activities on the problems they are supposed to address.

#### Bivariate Analysis

Although the frequency distributions give an idea of what is happening in a given department, the data can be used to provide much more detailed, focused information. Contingency tables present two variables in relation to one another, permitting comparison between them. For

example, method of alarm and resource utilization were analyzed together for the York Bureau of Fire, showing that response tended to be greater (specifically, more engines dispatched) for alarms over the City alarm system than for other methods of alarm. Three or more engines responded to nearly 42 percent of calls over the City alarm system, but three or more engines responded to less than 5 percent of telephoned alarms.

Bivariate analysis provides a more detailed picture based on the univariate distributions. The analyses in this study are limited to contingency-table analysis and one-way analysis of variance. The specific technique depends upon the level of measurement of the selected variables. The study concentrated on the following bivariate relations:

1. Time and location variables in relation to situation variables
2. Time and location variables in relation to resource variables
3. Time and location variables in relation to impact variables
4. Resource variables in relation to situation variables
5. Impact variables in relation to situation variables
6. Impact variables in relation to resource variables

Time and location variables in relation to situation variables. By examining the relationship between the time and location variables and the situation variables, it is possible to identify the patterns of specific demands for service. For example, in York it was determined which fire-alarm boxes are the major sources of false alarms (Box 135 and Box 247) and when these false alarms are likely to occur (1500 - 2359), based on past experience. With this knowledge, productivity could be improved if the particular alarm boxes could be watched by the police during the hours that a false alarm is likely to occur or if the response level of personnel

and equipment were reduced when there is a high probability of a false alarm. For police patrol where the analyses demonstrate patterns for particular calls for service, it is possible to make plans for responding to these calls rather than treating them as strictly random occurrences. In York, incidence of disorderly conduct in the central business district was relatively higher than in the rest of the City. Highly visible patrols in this area may help reduce the incidence, as well as be available for quick response.

Time and location variables in relation to resource variables. By analyzing the relationship between calls for service and resource variables, it is possible to utilize the resources more effectively and efficiently. If, as was expected, analysis showed that volunteer firefighters only showed up for fires during certain time periods, then productivity would be improved if the staffing of paid firefighters was reduced during the times of high volunteer participation and increased when volunteer participation was lower. Instead, it was shown that in York the number of volunteer firefighters responding to calls was not associated with time of day. There appears to be an association, however, between size of fire (property loss) and volunteer participation (an example of impact by resource variables). Volunteer firefighters tended to show up for the larger fires; 13 or more volunteers were present at 71 percent of fires with losses of over \$10,000. Three or fewer volunteers were present at about 93 percent of fires with no property loss.

Time and location variables in relation to impact variables. Analyzing the relation between time and location variables and impact variables, it is possible to identify factors associated with different levels of impact. For instance, police response time in York varied according to

location of the call for service. In some census tracts, response time was longer than 20 minutes in only 6 percent of the cases, whereas in other census tracts response time was longer than 20 minutes in over 17 percent of the calls. To thoroughly evaluate the effectiveness of such varied response times, analysis controlling for type of situation should explore the nature of calls for service. If emergency calls are not responded to quickly in some areas, action should be taken to determine why and to improve response time.

Resource variables in relation to situation variables. The bivariate analyses of the resource variables as they relate to the situation variables are important because they indicate the distribution of resource use for different types of calls for service. Time on scene for police officers, for example, varies according to the nature of the incident. In York, for example, it was found that crimes such as murder, rape, drunk-driving, narcotic offenses, and aggravated assault tended to require more time on scene than did other crimes (51 minutes or more). Over 87 percent of the murders and over 68 percent of the drunk-driving cases required more than 50 minutes to service. Manpower planning must take into account not only the frequency of calls for service, but also the time it takes to service a call. To increase productivity, efforts should be taken to reduce the time necessary for a patrol officer to process drunk-driving cases. Station personnel could process the case after the driver was driven to the station by the patrol officer. Doing this or using other support units, the officer could return to his patrol duties much sooner.

Impact variables in relation to situation variables. The most costly — in terms of loss of life, injury, loss of property, or resource



utilization— fires and police incidents (e.g., crimes, vehicle accidents) are often results of certain type of situations. Such situations, if identified, can be the target of prevention efforts so that repetitions can be avoided in the future. For example, in York nearly 40 percent of residential fires were ignited by kitchen stoves; if these could be prevented or their severity limited by quick, effective response by residents using fire extinguishers, the losses would be reduced.

Impact variables in relation to resource variables. As with the previous relationship, if the relationship between impact and the utilization of resources can be identified, then it is possible to adjust the mix of resources to achieve the desired results.

In addition to the associations described above, several others were studied. These include: Time and location variables in relation to time and location variables, resource variables in relation to resource variables, situation variables in relation to situation variables, and impact variables in relation to impact variables.

#### Elaboration Analysis

Analysis of the data can probe even deeper into the events. Analysis can take into account three variables at once, such as type of situation and time of day, controlling for location. For example, police management would be interested in developing strategies to help deter crime. By knowing that robberies are most likely to occur in downtown areas in the late evening hours (as found in York), whereas in some residential areas of the City, vandalism is a particular threat in the evening, measures can be taken to provide more specific citizen and property protection during these hours and to educate the public to the

dangers. In this case, three variables are examined together: (1) type of crime (i.e., robbery, vandalism), (2) time of occurrence, controlling for (3) location of occurrence.

Another interesting finding resulting from data analysis is the amount of time (manhours) and resources used in inappropriate demands for service—such as responding to false alarms or unfounded calls for police service. If the time and resources are being used for such things at an unacceptably high rate, management should establish priorities for service and procedures for responding.

#### D. Results

Results of this study demonstrate that systematic analysis of accurate data files provides a means for administrators to evaluate needs for productivity improvement in agencies of medium-size cities. Since the number of variables will be limited to several basic factors in most cases, the approach taken in this study is applicable beyond fire and police departments. Wherever management can manipulate levels and/or types of resources, personnel, and equipment to respond to demands for service, or where the frequency or severity of calls for service can be modified without lowering the quality of response and effectiveness, such analysis can be fruitful.

This section presents illustrative examples of findings from the fire and police departments covered in this study. The detailed findings and procedures for each city are included in the four technical reports mentioned previously. No general examples are presented from the Wilkes-Barre fire data because certain detailed data on calls for service and responses to such calls were not available. The examples

of police and fire data findings are classified separately and according to the complexity of the analysis. Complete findings are reported in each of the technical reports.

### Fire Data Analysis Findings

#### Univariate Analysis

Using data from the York Bureau of Fire, it was determined that on the average there were three times as many calls for service per hour between 1500 and 2359 as there are between 0500 and 0859. The implication here is that because of variation in the number of demands for service across a 24-hour period, staffing levels should be adjusted accordingly. While these figures begin to construct a picture of demand for management, more information for rational decision-making can be obtained through bivariate analysis. For example, it is necessary to determine if this pattern of demand held for all parts of the City.

#### Bivariate Analysis

Type of call by time. Although the highest number of calls for service occurred between 2100 and midnight for the York Bureau of Fire, this was also the most likely time for false alarms (31 percent of all false alarms). While there were 55 calls for fire suppression, there were 100 false alarms during the same time period. Thus, although fires are apt to occur in the late evening in York, because of the false alarms, personnel and equipment may be delayed in answering true emergencies. Clearly, the significant threat of false alarm affects the Bureau's response capabilities and should be considered as an unnecessary waste of resources when developing strategies for productivity improvement (see Productivity Improvement Recommendation 1).

Resource utilization by time. Analysis of the data for the York Bureau of Fire shows no important differences between the number of volunteer firefighters participating and the time of day of occurrence. This lack of a pattern with respect to time disputes the assumption that volunteers are likely to participate only during the nonworking hours. Instead, in York at least, the volunteer response was shown to be highest at the fires where property damage was greatest — the larger fires in the City. This would indicate effective use of the volunteer force; they were unlikely to respond in number to smaller fires (property loss of \$1,000 or less) but were available to help at the big fires. It is important to know how the volunteer force is being utilized in order to assure adequate levels of staff throughout the day, without hiring unnecessary firefighters.

Type of situation by resource utilization. Also in York, it was determined that the method of fire alarm is associated with the level of response in terms of personnel and equipment. Alarms received over the City alarm system were more apt to utilize more equipment and firefighters than were calls received by telephone. To illustrate, one or more trucks responded to 85 percent of calls reported over the City alarm system; while trucks responded to only 52 percent reported by telephone. Because more information could be obtained through a phone call, the dispatch was more appropriate for the type of situation. In contrast, the Bureau of Fire tended to send more firefighters and equipment when the type of situation was unknown. This is a particularly important consideration when related to method of alarm of false alarms; approximately 67 percent of the calls over the City alarm system were false, yet these tended to have the highest resource response. This finding indicates that false

alarms can be a major impediment to productivity (see Productivity Improvement Recommendation 2).

Type of situation by impact. Analysis of the York fire data shows that single-family residential structures were most likely to experience high property loss — that is, loss of \$10,000 or more. In terms of productivity improvement, this would suggest further examination of the circumstances leading to residential, single-family property fires and an attempt to prevent such occurrences. For example, as mentioned earlier, nearly 40 percent of residential fires were started by kitchen stoves. Prevention of such fires would reduce property loss greatly.

#### Elaboration Analysis

Generally two variables, such as time and method of alarm or manpower utilization and source of ignition, were analyzed while controlling for type of call for service (alarm, no fire; false alarm, fire; etc.). By focusing on a certain type of situation, it is possible to tell what patterns stand out, which types utilize more or less equipment and manpower, cause greater loss, occur at night, etc. In York, for example, it was determined that actual fires were relatively infrequent between the hours of midnight and 0459. When location of demand was included as a third variable, however, the pattern was reversed for the central business district where there was an increase in number of fires during this time period. Planning for adequate staffing must consider such variations within an overall pattern of occurrence in order to maintain or improve effectiveness.

## Police Data Analysis Findings

### Univariate Analysis

Analysis shows that in York the time period between 1500 and 0259 had the majority of calls for service. This suggests that patrol staffing patterns should reflect the demands for service, with supplemental personnel available during the peak hours. Another point shown in the data is that overall, in 69 percent of the cases, only one officer responded to a call for service. Three or more officers responded in less than 8 percent of the cases. The implication is that in almost all situations one or two officers can handle a call; i.e., additional backups are seldom called on. In terms of productivity, it is important to maintain adequate, but not unnecessary, levels of available manpower.

In Bridgeport, where the ambulance service is an administrative unit within the Police Department, the single most-frequent demand for service was for medical problems (10.3 percent of calls). This situation is sharply different from that in the York Bureau of Police, where requests for ambulance or fire assistance accounted for only 4 percent of the total calls for service. Obviously, the Bridgeport Police Department must allocate extra resources to respond to calls for medical assistance, whereas the York Bureau of Police does not have that constraint.

### Bivariate Analysis

Situation by time. In Bridgeport, analysis showed that nearly 60 percent of the disorderly conduct offenses occurred between the hours of 1500 and 2259, an 8-hour period. The Bridgeport data did not show other strong patterns related to time of occurrence. When patterns are evident, patrol strategies can anticipate the types of calls. Further

examination may reveal more specific relationships (e.g., location as well as time of crime) which would further refine police-patrol strategies.

Situation by resource utilization. As indicated earlier, overall, one officer responded to 69 percent of cases in York. This figure can be more meaningful when analyzed according to crime code. For example, one officer responded in 56 percent of the rape cases, while one officer responded in 90 percent of the theft incidents. Two or more officers were more apt to respond in murder/manslaughter, mental, weapons, and aggravated assault cases than in cases of other categories. The implications for productivity improvement are two-fold: (1) determine the extent to which the above-mentioned cases were facilitated by the presence of additional officers and (2) emphasize single-officer patrol except when and/or where incidents requiring two or more officers are indicated. Dispatch procedures should be developed to follow the same general rule.

#### Elaboration Analysis

Elaborating on the bivariate analysis, i.e., controlling for a third variable, more precise patterns of calls for police service and possible prevention targets become apparent. In York, for example, analysis of type of situation (crime code classification) by location (census tract), controlling for time, shows distinct patterns. Disorderly conduct offenses occurred primarily in the central business district. They occurred most frequently between 1500 and 2300.

Another crime code, vandalism, shows a pattern of occurrence that varied according to time and location. From 1000 and 1500, vandalism was most likely to be reported in residential districts; whereas between

1600 and midnight, vandalism was reported more often in the central business district and downtown residential areas. Police efforts at reducing vandalism or apprehending suspects would stand a greater chance for success if directed at the susceptible areas during times that have been shown to suffer frequent occurrences of vandalism. Additional results from analyses using other variables such as response times are presented in the technical supplements to this report.

#### E. Conclusion

The productivity projects demonstrated that systematic statistical analysis can be used to improve productivity in medium-size cities. The productivity-improvement recommendations presented here are direct results of analysis of routinely collected data in agency data files. The report suggests the types of variables that can be examined — time and location of demands for service and agency resource utilization in response to demands — to find more efficient and/or effective ways of matching appropriate resources with community demands.

More detailed discussion of the four studies, including results of the analyses are presented in technical reports on each of the four agencies studied. These reports are:

"Report on Productivity Improvement in the Bridgeport Police Department" (1977).

"Report on Productivity Improvement in the Wilkes-Barre Bureau of Fire" (1977).

"Report on Productivity Improvement in the York Bureau of Fire" (1977).

"Report on Productivity Improvement in the York Bureau of Police" (1977).