CREATING AN EFFECTIVE MATHEMATICAL MODEL FOR FUTURE RUN VOLUME PREDICTION

STRATEGIC MANAGEMENT OF CHANGE

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ABSTRACT

This project researched the best way of predicting future run volume based on known data gathered from the past. A mathematical model determining estimated run volume, based on the increase in population, was to be the end product. This model had to confidently predict run volume while being simple enough to use and understood by all involved. The underlying factor in the creation of this model was a failure in planning which grossly underestimated run volume.

Historical and evaluative research methods were used to support the action research necessary to complete the model. In order to develop this model, several questions had to be answered. A literature review was done (a) to determine if an existing model could be used, (b) to evaluate what other fire departments are using in their planning efforts, (c) to see if a relationship exists between run volume and population and the strength of that relationship, (d) to find an accurate model, and (e) to develop the data and skills to complete the model.

Research uncovered the theory of regression analysis as the best way to produce an accurate, effective model. To fully understand the calculations involved in the creation of the model a college level statistics class was taken. However, the Excel program found in Microsoft's Office 97 was invaluable in performing the math. The Excel program can easily be used by anyone with limited mathematical knowledge to produce a similar model. The National Fire Academy has published several important texts that related directly to this subject. All of the aforementioned resources were utilized in the creation of the model. A search was also begun to discover what other departments used

in their planning efforts. This was soon abandoned after limited responses and the discovery of regression analysis.

The recommendations following the creation of the model included (a) use of the model in future planning efforts, (b) input new data into the model and update yearly, (c) training in the use of the model, and (d) use of the model at budget request hearings to regain the confidence of our elected officials.

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INTRODUCTION

Since the late seventies, Union Township has been one of the fastest growing areas in the state of Ohio. The rush for the suburbs has created a population explosion within our fire district. Projections for the future do not see a change in this trend until well into the twenty-first century. The Union Township Fire Department has attempted to keep up with this growth. What began as a small volunteer department in 1963 has now evolved into a combination department with five fully staffed stations. However, we are still struggling to keep ahead of the increased demand for emergency services. In the past, we have used percentages to calculate the projected increase in emergency responses. This technique has proven to be less than adequate when trying to plan for future needs. What is needed is a simple, easy to use, understandable mathematical model we can use to project what our run volume will be based on increases in population.

The purpose of this project was to develop an effective, easy to use mathematical procedure to predict emergency responses dependant upon the population. Action research was supported by historical and evaluative methods in seeking answers for the following questions:

1. Does a mathematical model presently exist that can be used in our situation?
2. What do other fire departments use to predict response trends?
3. Does a relationship exist between population and responses?
4. How accurately will a mathematical model predict run volume?
5. What data and skills are required to produce such a model?

BACKGROUND AND SIGNIFICANCE

The Union Township Fire Department finds itself in an unusual position compared to other fire service organizations in our area. We are one of the few departments who are experiencing an increase in population, new home starts, industrial expansion, and demand for emergency services. Several of the departments surrounding us are facing serious financial cutbacks. Planning for this type of increase is difficult, although preferable to orchestrating layoffs. In the past we have used the previous year's percentage of increase to estimate the run volume for subsequent years. Our last five-year plan called for a ten percent increase in emergency responses. A twenty two percent increase was actually realized. This resulted in some embarrassment. The township administration, including our elected officials now has serious doubts about our ability to plan effectively. Planning is a critical function that should be expected of any executive fire officer.

> Planning is a basic step in fire protection management. Texts on the subject universally list planning as one of the major management functions, usually the first. Timely and dynamic fire protection planning provides the basis for systematic control of current and future fire risks and efficient and effective use of fire protection resources, thereby limiting fire losses and fire protection costs. (International City Management Association [ICMA], 1988, p. 77)

We are now in the process of revising our five year plan. Knowing that a greater increase in service demand is inevitable, how can we accurately predict what that demand

will be? I believe that we can produce a mathematical model, based on past data, that would predict future trends in our community. Proper data gathering and analysis is vital to the construction and use of the model in planning.

> Data should be developed that identify the current and future fire protection risks, service demands (including EMS and hazmat) fire protection capabilities, financial requirement and revenues, and legal constraints…..The accuracy and thoroughness of the plan to be developed will depend on the quality of the data collected. This will be most evident later, when the time comes to measure progress toward the objectives that have been established for the implementation of the plan. (ICMA, 1988, p. 88)

The model that would be created in this process would be used in analyzing future needs in our fire department. The importance of analysis was highlighted in the National Fire Academy's course "Strategic Management of Change". The second module of the course introduces the "Change Management Model".

> The purpose of this model is to introduce a model which will enable you and your organization to effectively address change by identifying where you want to go, determining how to get there, measuring your progress, and recognizing when you have arrived. (National Fire Academy, [NFA], 1996, p. SM 2-3)

The first step in using the model is the analysis phase that entails gathering data to determine whether a change is necessary or not. This is where the mathematical model for predicting run volume would have the most impact. In place of the percentages we

now use, the new model will allow us to base increase on solid data using statistical analysis to avoid the pitfalls of our previous planning effort. This project will attempt to create the best model possible to achieve the best utilization of available data.

LITERATURE REVIEW

This literature review deals with information gathered from National Fire Academy Publications, a college level statistics course taken at the University of Cincinnati and the Microsoft Excel program found in Office 97.

The National Fire Academy.

Several publications produced by the National Fire Academy were reviewed and utilized to create a mathematical model. "Analytical Approaches to Public Fire Protection", the 1992 revised edition, provided valuable information. The introduction to this text placed significant importance on the use of analytical process and justified the effort required to manufacture the model.

> The list of analytical problems in public fire protection is almost endless, limited only by the imagination and creativity of those willing to prepare themselves to use analytical techniques. The availability of personal computers and software has increased greatly. There is in place in most municipal fire departments a vast potential for dealing with many of the systems that have created problems for years, but which could not be addressed in the academic community…..The availability of software and the necessary data may help to narrow the gaps between the subsystems that provide basic solutions to public fire protection problems. (National Fire Academy, [NFA], 1992 Introduction)

In unit three of the text, statistical analysis is discussed. The concept of linear functions appears to be directly related to the type of model I wish to develop. “Many relationships between variables are associated with the proportional growth of one relative to the other” (NFA, 1992 p.3-1). The method to use when deciding if data is linear is to graph the information and attempt to draw a line through the plotted points. If the line appears to be straight then the data is said to be linear and a direct relationship exists between the values. An equation of the line can then be developed which would allow you to plot a trend line deriving future information based on knowledge of only one value. The equation for this line is $Y = b + (X - a)M$ where $M = (b-d)/(a-c)$, (a,b) and (c,d) are two known points located along the graphed line. M represents the slope of the line in other words how rapidly the line ascends or descends. The use of this equation requires some basic knowledge of algebra. However, it is a relatively simple equation to use. The text also allows the use of nonlinear equations. There are several ways to use nonlinear data to develop a model. “Three special transformations are used frequently by those working with models for systems” (NFA, 1992 p.3-5). If the data does not fit a straight line the first transformation to attempt should be the square root of one of the variables. Graph the new points and see if a line is formed. When acquiring data from this line remember to square the value to come up with the proper number. The text provided this clue to utilizing the square root transformation “if the data tend to move upward somewhat faster than a strait line, the square root transformation is helpful in approximating the square root of the value being sought” (NFA, 1992 p.3-6). A bit more mathematical knowledge is required to use the other two transformations. The logarithm using base e applied to one variable will accomplish the same as the square root. A scientific calculator can be

very useful for this function. Entering the value and pressing the "ln" key will give you the base e logarithm of that value. To interpret values derived from this line you must use the e^x key, usually found as the "ln" key in second function. The final transformation uses the e^x key initially to transform data then the "ln" key to interpret the trend. The National Fire Academy's Analytical Approaches to Public Fire Protection provided a great deal of information but was especially useful in the area of linear functions. This text also provided a warning about extending the line past known data to predict future events.

> We must be careful if we wish to extend the analysis several years forward. In order to describe the future using the data from the past, we would have to assume that all other things remain the same. This can be assumed, but the consequences can create massive errors. The process of extending the description of the system several years into the future is called extrapolation. There is no rule for doing this—there is only the measured judgment of the observer. (NFA, 1992 p.3-10)

A second book published by the National Fire Academy is the Fire Data Analysis Handbook. This handbook is tailored to allow fire departments with not much mathematical background to benefit from the use of statistics.

> This handbook has a primary objective to describe statistical techniques for analyzing data typically collected in fire departments. Motivation for the handbook comes from the belief that fire departments collect an immense amount of data, but do very little with the data…..In a nutshell, this handbook describes statistical techniques to turn data into information for answering

> questions. (Federal Emergency Management Agency, 1995 p.1)

The first part of the book is a good review of basic statistic principles. However, chapter seven introduced the theory of correlation and regression analysis. "Correlation is a statistical measure which indicates the degree to which one variable changes with another variable" (FEMA, 1995, p.107). With correlation a strong relationship can be proven, or disapproved, between population and run volume. Correlation will also give a numerical value representing how strong the relationship is. This relationship is calculated by determining the standard units (z-score in some texts) from the mean and standard deviation of the data. The closer the final correlation number is to 1 the stronger the relationship of the two variables. Regression will create a straight line with the given data along with a corresponding regression equation.

> With regression we go a step further and create a strait line, with an associated regression equation, through a group of points. The result is as an analytical description of the relationship between two variables. The regression equation defines the strait line algebraically. (FEMA, 1995, p.107)

The regression line is found in the general form of $y=Mx+b$ where y is the dependent variable (run volume), x is the independent variable (population), M is the regression coefficient (slope) and b is the intercept. This equation should look familiar as it is the same one used for linear equations described previously. The example problem in this chapter is very similar to what I want to create as a model for my department. This gave me the confidence that I was on the right path to solving our problem. This book also exposed knowledge weaknesses in the field of statistics. It is vitally important to the creation of a model that functions such as standard deviation, z-scores, regression, and

coefficients be understood. A formal class in statistics was taken at the University of Cincinnati.

The University of Cincinnati

A one quarter class in elementary statistics was taken during the spring of 1998 at the University of Cincinnati. Sandra Franz used the text Elementary Statistics by Neil A. Weiss in conjunction with classroom instruction. Much of the same materials previously mentioned was reviewed as well as the finer points of basic statistics. This course and text provided the necessary foundation which was critical for the development and understanding of a mathematical model. Subjects such as median, mean, probability, standard deviation, graphing, the standard normal curve, sampling distribution, confidence intervals and chi-square procedures were covered. While studying the contents of these chapters, a new appreciation was realized for the subject matter from the National Fire Academy. Chapter 13 of the text, covering regression and correlation, proved to be paramount in the development of a model. The regression equation was discussed in section 13.2. This lead to a method called the least-squares criterion which enables one to select the best line that will fit a set of data. Typically data will not align itself in a strait line, however, the points may be scattered about a strait line. The least-squares criterion is utilized to determine that line.

> Since we could draw many different strait lines through the cluster of data points, we need a method to choose the "best" line. The method employed is called the **least-squares criterion.** It is based on the analysis of the errors made in using a strait line to fit the data points. (Weiss, 1996, p.655)

Another important concept presented in this chapter is the coefficient of determination. By using two computations you can determine whether the regression equation or using the average will offer the most accurate predictions. This coefficient, labeled r^2 , is derived by calculating the total sum of the square, abbreviated *SST*, and the error sum of squares, abbreviated *SSE*, then dividing *SSE/SST* and subtracting that total from 1. Interpretation of the number resulting from these computations is explained by Weiss.

> In any case, r^2 always lies between 0 and 1 and is a descriptive measure of the utility of the regression equation for making predictions. Values of r^2 near 0 indicate that the regression equation is not very useful for making predictions, whereas values of r^2 near 1 indicate that the regression equation is extremely useful for making predictions. (Weiss, 1996, p. 678)

The remainder of the chapter covered correlation, r, and the relationship of correlation to the coefficient of determination, r^2.

> We expect the strength of the linear relationship to also indicate the usefulness of the regression equation for making predictions. In other words, there should be a relationship between the linear correlation coefficient and the coefficient of determination, and there is. The relationship is precisely the one suggested by the notation. (Weiss, 1996, p.685)

Simply stated the coefficient of determination is the square of the linear correlation coefficient.

The course at the University of Cincinnati ended with this chapter. Not only did this class provide the background needed to complete a mathematical model it also provided useful insight on a variety of statistical information presented to the executive fire officer on a daily basis.

Microsoft Excel

At the insistence of my college statistics instructor I looked into several computer programs that can do this work for me. I chose the Excel program from Microsoft found in Office 97 because it was readily available and quite easy to use. Simply by entering the raw data, the program will calculate any statistical information you require, as well as creating scatter diagrams and plotting regression lines. Use the *fx* icon to gain access to the mathematical control window. Then, by choosing statistical, there are numerous functions, which enable one to obtain the desired results. The program is capable of tabulating slope, intercept, standard deviation, correlation, sum of squares much easier, faster, and with greater accuracy than doing it by hand. To extrapolate data it is best to use the TREND function. This function returns values along a linear trend using the method of least squares. The Excel program also allows user derived functions to be used. An unlimited number of calculations can be performed. The Excel program will be utilized throughout the remainder of this project. Any attempt to calculate these statistics by hand should be reserved until after attending a formal statistics class.

PROCEDURES

The end result of this project is to create and utilize a mathematical model that will predict run volume based on population. This model must be effective and based on sound statistical theory. The Union Township Fire Department will use this model to

justify the need for change within our organization and to foster a sense of urgency in our elected officials. The model must be complex enough to include as much data as possible yet simple enough to be easily understood and graphically represented. Historical research was completed via a literature review of publications from the National Fire Academy as well as the authors' participation in a college level statistics class. Knowledge gained through this research was utilized in the creation of a mathematical model for predicting run volume based on population. In this section the procedure for determining total run volume vs. population will be explained. In the model found in appendix A there are three different models found: total run volume, fire run volume, and medical call volume. These three different dependant variables were determined to be significantly different enough to justify their own separate model.

There are some limitations involved when attempting to use data such as population. There is only an accurate count of population once every ten years. The remaining population figures were estimates gathered from local governmental agencies. The emergency response totals were taken from hard copy records found in the fire department archives. However, I was informed that prior to 1976 no records were kept. This limited the scope of information to only 22 years. The final caveat is extrapolation of the data. As previously noted it can be dangerous to rely on predictions. Taking this into consideration predicting future trends must be not only mathematical but also rely heavily on changing conditions that may effect the independent variable.

The initial step in developing any model is to decide what you want the model to do. Using the model developed for the Union Township Fire Department, our particular model will tell us the estimated run volume based on population increase (I will be using

this model as an example throughout this section). When one variable (run volume) relies on another (population) there is said to be a relationship between these two. The dependant variable, y, is effected by the independent variable, x. The two variables used in our model are displayed below in table 1.

YEAR	POP. (thousands)	RUNS
1997	55510	4495
1996	54213	4121
1995	51416	3564
1994	49963	3295
1993	48296	3106
1992	45673	2716
1991	43453	2589
1990	41375	2357
1989	39703	2239
1988	36420	2134
1987	33109	1753
1986	31750	1679
1985	30272	1575
1984	28101	1389
1983	27400	1335
1982	25991	1263
1981	25906	1504
1980	23553	1585
1979	22621	1362
1978	21593	1399
1977	20471	1312
1976	19320	1215

Table 1. Population and run data by year.

Since run volume is the output of the model based on population, run volume is the dependant variable, y. Population, then, is the independent variable, x. Entering this data into a database program such as Microsoft Excel will make the remaining computations much easier.

Plotting these points on a graph will reveal if the data is linear or not. Remember non-linear data can be transformed for a better line fit. This plotting is called a scatter diagram. The following scatter diagram (table 2) was created from the above data by the Excel program:

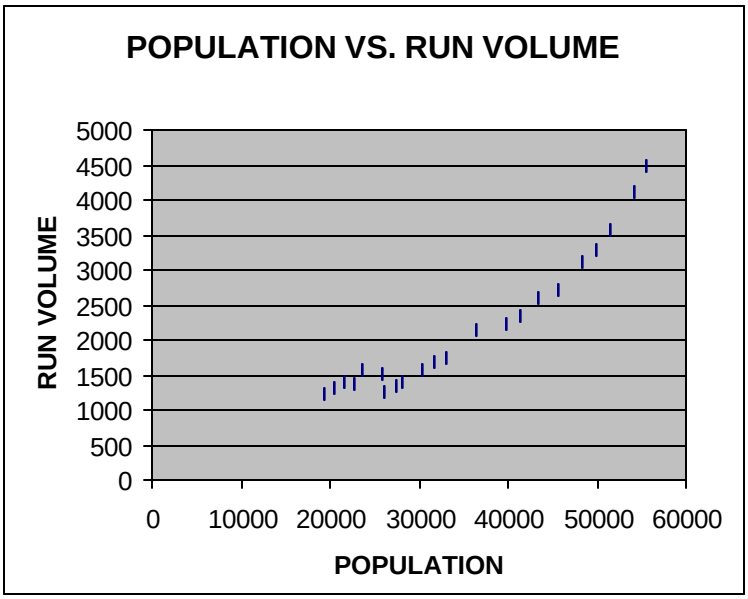

Table 2. Population vs. run volume scatter diagram

This diagram shows that the data is generally linear and may be used as is. Therefore, no conversion is necessary. The scatter diagram shows a relationship between both variables. The strength of this relationship will determine how accurate the results of a model will be. Correlation is the statistic used to represent the strength of this relationship. Correlation is always a number between –1 and 1. The further away from zero, the better the relationship. Correlation can be calculated through a series of steps which force you to find the standard deviation and mean. The Excel program, however, allows for easy calculation of correlation. Simply select the *fx* icon, choose statistical and correl, the computer then prompts you to enter the data arrays. Correlation is automatically displayed. The correlation for the above data series is .955 indicating a strong relationship between the two.

Correlations are always between –1 and +1. Stronger associations are indicated as the correlations approach –1 and +1, while correlations close to 0 indicate no association. With positive correlations, the dots

> move from lower left to the upper right, while with negative correlations the opposite is true. (FEMA, 1995, p.112)

The coefficient of determination has been previously described as a number that will reveal how useful the data is at making predictions. To arrive at this number simply square the correlation. In our example the correlation is .955. Squaring this number gives .912, which is the correlation of determination. Since this number is very close to 1, our data will be very useful for predicting run volume.

When assured of a strong relationship, the next step is to plot a trendline using the method of least squares. This can be done easily by highlighting the scatter diagram, left clicking on the mouse and selecting trendline. This returns a line based on the method of Least squares as shown in table 3.

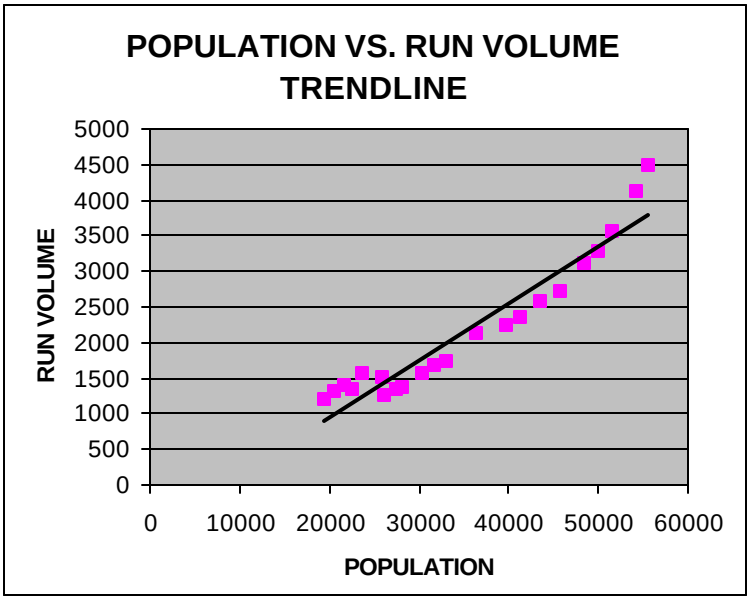

Table 3. Trendline for population vs. run volume data.

The extending of this line is one method of extrapolating data. Select the population expected in the future, extend the line to that point and read the run volume number along

the y axis. There is, however, an easier and more accurate method of predicting future trends. A description of the trendline can be developed by finding the slope and the Y-intercept and substituting them into the equation y=mx + b. Slope is written as m in this equation and the Y-intercept is b. The y value is the result being sought; in this example run volume. The x value would be the known or estimated co variable; population in this case. The slope of the example data is .0796 and will be substituted into the equation in the m position. The Y-intercept of the data is –628.09, and will replace the b in the equation. The completed equation is: y = .0796x – 628.09. Population estimates can now be directly input into the equation to determine run volume. For example if the run volume for a population of 100,000 is required then the equation would be Y = .0796(100,000) – 628.09. Completing the equation yields a final result of 7332. The result of this work states that with a predicted population of 100,000 the run volume will be close to 7332 runs. The slope and Y-intercept are also functions in the Excel program allowing for the development of these equations in minutes.

RESULTS

A completed, ready to use, model for predicting run volume is found as appendix A. This model includes equations for the prediction of total run volume as well as fire and medical responses.

Answers to Research Questions

Research Question 1. Research uncovered several types of mathematical models that could be utilized in predicting run volume. Computing the percentage of increase then using this percentage to predict future volume was attempted by our department with miserable results. Using the average increase was also inaccurate because an average

does not take into consideration the changing population. The Fire Data Analysis Handbook from the United States Fire Administration was particularly helpful in identifying the proper model to use. This book clearly demonstrated the usefulness of regression in creating a model.

> We found, for example, a high correlation between population of jurisdictions and the number of fires. Regression analysis provides a way to quantify the relationship of two variables. The regression line is a representation of the scatter diagram of the two variables. We can apply the regression line to estimate the value of one variable given the other variable. With the regression of population on fires, for example, we can make estimates on the number of fires that a jurisdiction can expect given its particular population. (FEMA, 1995, p.125)

Replacing fires with run volume will produce the desired model. The instructions in the Fire Data Analysis Handbook were very easy to replicate. An equation was simple to produce. Understanding statistics, however, was difficult until completion of a formal class. The short answer to research question number one is yes. There is indeed an acceptable model presently available that can predict run volume based on population.

Research Question 2. No formal survey was done to find the answer to this question. I did post the question on both the Ohio Fire Chiefs web site, as well as on the ICHIEFS web site. Limited responses were obtained. Several personal contacts were made with fire departments in my area. Most other fire service agencies tend to rely on percentages for both increases and decreases. To be perfectly honest, after finding such

an effective model as described in the Fire Data Analysis Handbook, the search to find out what other departments do was abandoned.

Research Question 3. My theory was that a relationship did exist between population and run volume. It only stands to reason that if you increase the population in a given area that demand for emergency service will also increase. Our department is living proof that this theory is correct. However, I was not sure of the strength of this relationship. The development of an effective model relied upon the relationship of these two variables. A statistical function, correlation, is essential in determining how deeply one variable effects or is effected by another.

> Correlation and regression analysis are two powerful tools for analyzing the relationship between two continuous variables. A correlation close to zero tells you there is no relationship, which means that knowing the value of one of the variables does not tell you much about the value of the other variable. Correlation close to –1 or +1 indicate a strong relationship between two variables. (FEMA, 1995, p.125)

Correlation will vary depending on the particular data you use. Total run volume for my model had a correlation of .955 indicating a strong relationship. Medical call correlation was .981 which shows an even stronger dependence. On the other hand, fire response ended up with a correlation of .861 a good relationship but weaker than the others.

Research Question 4. Perhaps the most important factor in the creation of the model was the accuracy of the results. Every text reviewed included a disclaimer for extrapolating data from regression analysis. This is due to the fact that the mathematical model is unable to take change in the community into consideration. The operator of the

model should be able to input the human factor in deciphering results. The model must be used in conjunction with knowledge of the community, economic conditions and consumer demand. To use the model as the only factor in predicting run volume would be a mistake. However, the coefficient of determination will show how useful the model can be when making predictions. As previously shown, the coefficient of determination has a direct relationship with the correlation of the data. The coefficient of determination is the correlation squared. Doing this for the correlation of total runs, medical runs and fire runs resulted in coefficients of .913, .963 and .742 respectively. The closer to 1 these figures are, the more accurate predictions can be made. Another way to interpret these numbers is in comparison to using average increases.

> We can interpret r^2 in the following way. With the regression equation the amount of error in the prediction (as measured by the sum of squared errors) is 91.3 percent smaller than when the average is used as the predictor. The value r^2 therefore indicates how much better the linear regression equation is over simply using the average. (FEMA, 1995, p.122)

The numbers obtained for the model produced by this research project demonstrate that confidence should be placed upon the results.

Research Question 5. The data needed to complete the model was relatively easy to find. The two variables, emergency responses and population, were documented in yearly reports from 1976 to present. Data prior to 1976 is sketchy and unreliable. An attempt, however, is being made to uncover good data from this time period and incorporate it into the model. Population can be considered accurate only once every ten years, where the information is derived from the census. Every other year is an estimate.

The skill required to assemble this information into a computer database, run the required calculations and interpret the results is minimal. This task is made easier by a computer program such as Microsoft Excel. To do the equations by hand or to achieve an in depth understanding of the process requires, I believe, a formal class in statistics with a strong mathematical background.

DISCUSSION

The end product of this research paper is the mathematical model found in appendix A. It is anticipated that this model will assist the Union Township Fire Department in planning efforts as related to future run volume. The model is simple enough to be understood and quickly explained but yet sufficiently thorough to withstand evaluation by others. The users of this model, or any other statistical information, must not forget to factor in their own personal judgement and experience. Without this human intervention the model simply produces numbers that may or may not be reliable.

This project began with a recognized need for more accurate predictions of fire department workload. As with any problem, it quickly became an in depth search for more and better information. Only after my participation in the college level statistics class did I fully comprehend and became able to utilize the information in the literature from the National Fire Academy. I can now review statistical information in a new light. The correct interpretation of graphs, charts, and mathematical results is an important asset to an executive fire officer. One surprise I encountered during the literature search was the lack of information on this subject found in many “fire service bibles”. The Fire Chiefs Handbook made no mention of statistical analysis. Neither did the NFPA Handbook or the International City Management Association’s Managing Fire Services

text. I feel that statistical analysis, especially the use of regression analysis, is critical for all executive fire officers to know and understand.

RECOMMENDATIONS

The mathematical model for predicting run volume should be utilized in the development of the Union Township Fire Department's five year operating plan. This plan, as well as the model, will assist us in implementing the change necessary to keep pace with our growing community.

New information, gathered yearly, will be input into the regression equation. The model will then be updated to reflect the population served. There is also an attempt at recreating, or discovering the data on emergency responses prior to 1976. If found and deemed to be accurate this data will also be entered into the equation. The end result should be a model with greater accuracy.

Those who will utilize the model should be trained in the use of the model. I do not believe that an in depth training session will be required. Therefore, the model can be introduced at our next planning meeting.

Finally, we will utilize this model at budget request hearings in front of the elected officials. It will be nice to regain the confidence of the individuals who hold the purse strings. With a solid statistical model we should be able to effectively sell our five year plan.

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APPENDIX A

MATHEMATICAL MODEL FOR PREDICTION OF RUN VOLUME

Data and Calculations:

YEAR	POP. (thousands)	RUNS	EMS	FIRE
1997	55510	4495	2475	2020
1996	54213	4121	2323	1798
1995	51416	3564	2293	1271
1994	49963	3295	2063	1232
1993	48296	3106	2020	1086
1992	45673	2716	1904	812
1991	43453	2589	1869	720
1990	41375	2357	1697	660
1989	39703	2239	1592	647
1988	36420	2134	1484	650
1987	33109	1753	1200	553
1986	31750	1679	1163	516
1985	30272	1575	1024	551
1984	28101	1389	918	471
1983	27400	1335	879	456
1982	25991	1263	837	426
1981	25906	1504	1001	503
1980	23553	1585	1046	539
1979	22621	1362	907	455
1978	21593	1399	928	471
1977	20471	1312	871	441
1976	19320	1215	751	464

Correlatio	0.955461	0.981452	0.861366
Coefficient of determination	0.912905	0.963249	0.741951
Intercept	-628.087	-238.41	-389.677
Slope	0.079634	0.047017	0.032618

Equations: Based on Y = Slope(x) + Intercept

Y = run volume

X = population

Total Run Volume: Y = .0796x – 628.087

Emergency Medical Run Volume: Y = .047x – 238.41

Fire Run Volume: Y = .0326x – 389.667