THE APPLICATION OF A MATHEMATIC DECISION MAKING MODEL TO THE CONSOLIDATION EFFORTS OF FIRE SERVICE ORGANIZATIONS

STRATEGIC ANALYSIS OF FIRE DEPARTMENT OPERATIONS

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For Reference

Not to be taken from this room

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Abstract

The purpose of this study was to determine if a mathematical decision making model could be applied to successful consolidation efforts of fire service agencies for the purpose of determining a preferred strategy for implementing a consolidation effort.

The research questions addressed in this project were:

* What were the existing mathematical decision making models, and which if any could be applied to consolidation efforts?

* What were the common obstacles (if any) encountered by organizations who undertook successful consolidation efforts?

* If there were common obstacles or steps in which order did those successfully implementing consolidation efforts approach them?

* Can a model be developed which will statistically illustrate the points of greatest resistance encountered by successful consolidation efforts and the paths of greatest success?

Both historical and descriptive research methods were employed. Historical research revealed the existence of a mathematical model that could illustrate the condition of a system as it moves through varying states. This is called Markov Analysis. Descriptive research was utilized in the form of a survey to thirty-two agencies which had successfully completed some form of consolidation effort. A survey was designed to determine if common obstacles identified in the literature were, in fact, experienced by all agencies. Additionally, the survey was designed to determine in which order the existing management felt these obstacles occurred in the process.

This study resulted in the construction of a Markov Analysis Model which illustrates a mathematical probably of successful consolidation effort, given four separate states or obstacles which all consolidation efforts went through. The four states were employee

resistance, basic resistance to change, autonomy and identification issues, and inter-jurisdictional/political issues.

Recommendations of the study include a preferred pathway for managing successful consolidation efforts and a recommendation for further study in the area of unsuccessful consolidations.

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Introduction

Consolidation of Fire Services on a regional basis is a trend which seems to be strengthening as economic conditions worsen. The concept of consolidation has been explored at depth. However, in the search of literature and in interviews with people familiar with the topic, there was very no information available on how consolidation efforts fall within any of several mathematical decision making models. The availability of this type of information would allow staff and elected officials desirous of consolidating with other organizations to identify and quantify pitfalls and "paths of least resistance" in the consolidation effort.

The purpose of this study is to determine if it is possible to apply a mathematical decision making model to the consolidation process and determine areas, stages, or quantifiable steps that may provide the decision maker with information that may facilitate the consolidation process.

The research method to be utilized in this study is primarily historical; in determining what mathematical decision making models exist or may apply to the consolidation process and in determining what identifiable steps or processes other consolidation efforts have gone through. Secondarily, a descriptive research method will be conducted of several agencies who have gone through a consolidation effort to determine at what stages of development they encountered any resistance and the degree of that resistance.

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The following research questions will be addressed:

What are some of the existing decision making models and which, if any can be applied to the consolidation process?

What are the common problems (if any) identified by those who have conducted consolidation efforts?

If there are common steps to the consolidation effort, in what order did those undertaking the consolidation effort approach these steps?

Can a model be developed which will illustrate statistically the greatest points of resistance and the routes with the greatest degree of success in consolidation efforts?

Background and Significance

Consolidation efforts among fire service agencies is nothing new. A review of the literature can reveal a surge of interest in this area as early as the mid-1970's. While there has been a great interest in this subject, all of the literature found dealt with the technical aspects of consolidation; the impacts on training, purchasing, fire prevention efforts, communications, and operations.

It is also obvious from the literature, that the effort to consolidate is ripe with political agendas and community pride. Almost all authors agreed that may "surprises" occurred within the consolidation process, some of which proved fatal to the otherwise logical and well intentioned effort.

Lacking in the present literature and discussions relative to consolidation is a discussion on what those "surprises" are, where they often emerge, how often they prove fatal or are minor irritants, and the impact on the effort of addressing these issues in a

particular order.

The availability of this information could help the professional fire service manager better manage the consolidation process and provide for a higher degree of success than is typically found today.

This topic relates to the Strategic Analysis of Fire Department Operations in that the existing literature contains a wealth of information on the impacts of consolidation on operational efficiency. Therefore, if a better understanding exists on how to best achieve those efficiencies, the fire service will benefit.

Literature Review

The United States has an abundance of jurisdictions providing fire protection services. According to Picard (1975), there are over 3,000 counties, 18,000 municipalities and 17,000 townships employing over ten million people and spending over $100 million on fire protection services on an annual basis in the United States. It is a small wonder then, that increased efficiencies are sometimes sought through consolidation of existing systems.

Blanchard (1989) notes that the trend for consolidation on a county wide basis goes back as far as the 1920's and that recent county-wide consolidations have occurred because of a change in charter or government structure. But consolidations can occur on a basis other than that provide by the county government structure.

Functional consolidations are very evident in a review of present literature. Rule (1976) and Pepler (1982) convey the positive impact that consolidation can have on the

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training function and on training facilities. Consolidation of the communications function has proven its ability to save money and reduce personnel (Olsen, 1985).

The cost effectiveness of consolidations is recounted time and time again in the literature. Doyle (1983) estimates that the consolidation of Pasco County, Florida saved taxpayers over $500 thousand in duplicative services and equipment. Strueli (1970) relates the success story of Contra Costa County where the ISO rating was reduced from a six to a four at a reduced cost through consolidation. The Western Fire Journal editorialized in 1979 of the savings that consolidations could bring to communities.

Despite all these seeming advantages, consolidations are not a sure bet. The literature also relates stories of unsuccessful consolidations.

Blackwell et al. (1983) identify four primary considerations that each consolidation effort must pass through. They are basic resistance to change; autonomy and identification issues; inter-jurisdictional and political considerations; and employee issues.

While most people take decision making for granted, it has been the subject of study for at least sixty years. Current literature states that by examining the decision making process, human can greatly improve upon and accelerate their decision making capacity. Barnard (1938) states that "the capacity of most people to make decisions is quite narrow, although... it can be developed...especially by experience."

A review of the relevant literature reveals that there are many decision making models available to the author. Basically, mathematical decision making models are described as being either normative or descriptive. Normative models are models which prescribe the course of action to be taken by the decision maker. Descriptive models

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describe things as they unfold and as they are. Descriptive analysis is used to investigate the consequences of various courses of action (Turban and Meredith, 1977). As such, it was determined to narrow the focus of this study and review on descriptive analytic models.

Several descriptive models were reviewed and examined. Game Theory (Buchler and Nutini, 1969) was considered and dismissed as requiring to many independent variables. Other descriptive models including Line Waiting models, Inventory Models, and Dynamic Programming Models were reviewed and dismissed (Turban and Meredith, 1977). Mine and Osaki (1970) present Markov Analysis as a method of "describing the behavior of a system in a dynamic situation. Specifically, it describes and predicts the movement of a process among states as time passes".

Procedures

This research project consisted of both historical and descriptive research models. The author conducted a search of the existing literature utilizing the Learning Resource Center of the National Fire Academy and the Library of San Diego Miramar College. The purpose of this search was to identify existing information on the consolidation of fire protection services and identify, if possible, common elements or scenarios which could serve as the basis for a descriptive study. Additional research was conducted in the area of decision modeling. The purpose of this research was to determine if a mathematical decision model existed which could be utilized to describe and predict the success of various alternative routes through the common obstructing elements to consolidation

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discovered in the previous literature.

Upon conclusion of this study, a survey was developed and mailed to a population consisting of thirty-two agencies which were either identified in the literature as having been involved in a consolidation effort or directly known by the author to have been involved in a consolidation effort. The survey sought to identify in what order and to what degree obstacles identified in the literature as being common to most all consolidation efforts, impacted the efforts of those organizations in the study population.

Upon receiving feedback from the subject organizations a statistical Markov Analysis was prepared to illustrate the various probabilities of a given consolidation effort reaching a given stage of development given a pre-determined path through the pre-identified common obstacles.

The Markov process describes the movement of a system from one condition to another. The probability of a given movement through a system, termed the "transition probability" (P_{ij}) is the likelihood that the system in a given state i will move to a state, j in a given period. The probability that the system will move to a particular state i, at period k is denoted by the algebraic equation $q_1(k)$. Since the system can only occupy one and only one state at any given period, then the sum of all q_1 values must equal one. This can be represented as follows:

$$q_1(k) + q_2(k) + ... + q_n(k) = 1$$

The "state probabilities", that is the probability distribution of the system being in any given condition at any given period (k), can be written as follows:

$$Q(k) = [q_1(k), q_2(k),...,q_n(k)]$$

The relationship between the transition and state probabilities can now be represented in a decision tree diagram (See Appendix "A").

For purposes of this study, "states" where identified as the four, distinct obstacles identified in the literature as consistently affecting consolidation efforts; basis resistance to change, autonomy and identity issues, inter-jurisdictional and political issues, and employee issues (Blackwell et al., 1983). The survey asked agencies to identify when in the process did they recognize these obstacles as appearing and what other, if any, obstacles or resistance did they note, and in what order did they become evident. Placing the results into a Markov analysis a decision tree model was constructed illustrating the varying degrees of probability associated with following a given path through the consolidation process.

Results

The research conducted in this study revealed that a mathematical model of decision making does exist which can describe the probabilities of various courses of action in the consolidation process. This model is known as Markov Analysis. From this analytical model the author was able to construct a model, based upon the experiences of fire service managers who have attempted consolidation efforts, which can describe the various probabilities of success of a given course of action. A complete breakdown of the mathematical results can be found in Appendix "B". A Decision Tree diagram is included for reference as Figure R-1.

There does exist certain common obstacles or elements that consolidation efforts

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seem to go through. The literature indicated that among these are: Basic Resistance to Change, Autonomy/Identification Issues, Inter-jurisdictional/Political Issues, and Employee issues.

An analysis of the survey mailed to thirty-two fire agencies involved in consolidations revealed that there was a definite trend in determining the order in which these identifiable obstacles were addressed. The transition and state probabilities were determined given these findings and a Markov Analysis conducted to outline the probabilities of a given consolidation effort reaching a certain state via a given path.

Discussion

Not all successful consolidation efforts went through all four states as described by Blackwell et al. (1983). Of the thirty two surveys mailed out, twenty-five were returned and eighteen stated that they has successfully completed a consolidation effort. Of those thirteen, nine (69.2%) stated that they did experience all four states. Thirteen of the eighteen (72.2%) stated that they experienced employee resistance; 55.5% stated that they experienced basic resistance to change; 44.4% stated that autonomy or identify issues represented a significant issue; and 33.3% stated that inter-jurisdictional issues needed to be overcome.

The two greatest transition states were from Employee Issues to Basic Resistance to Change and the continuation of autonomy issues through more than one easily identifiable time transition (both at 61.5%). The second greatest transition probability was from Basic Resistance to Change to Autonomy Issues (44.4%). This would seem to

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indicate that Autonomy Issues present the greatest obstacle to successful consolidation efforts and that those efforts that are successful spend an inordinate amount of time dealing with issues of Autonomy and Employee Concerns.

Also of interest is the fact that not one respondent listed Inter-jurisdictional Issues as the primary obstacle faced and no respondent indicated a transition from Inter-jurisdictional to any other transition state. This would seem to indicate that Inter-jurisdiction and political concerns is the critical path toward successful consolidation and once addressed, no further transitions are necessary. Also implicit in this data is the belief that inter-jurisdictional/political issues can be addressed at other stages of the process, most probably the autonomy/Identification stage. The highest probability of successful consolidations follow a state change from Employee Resistance to Basic Resistance to Change to Autonomy/Identification Issues. The least traveled path of successful consolidations started with addressing Inter-jurisdictional/Political obstacles which produced no transition states at all. The next lowest transition state for successful consolidations was from Autonomy/Identification to Employee Resistance. It would seem reasonable to conclude from these patterns that obtaining the commitment of the members of the organization's involved is critical to the successful completion of a consolidation effort.

Recommendations

It is recommended that managers of fire protection agencies seeking to successfully consolidate with another jurisdiction be aware of, and manage his or her
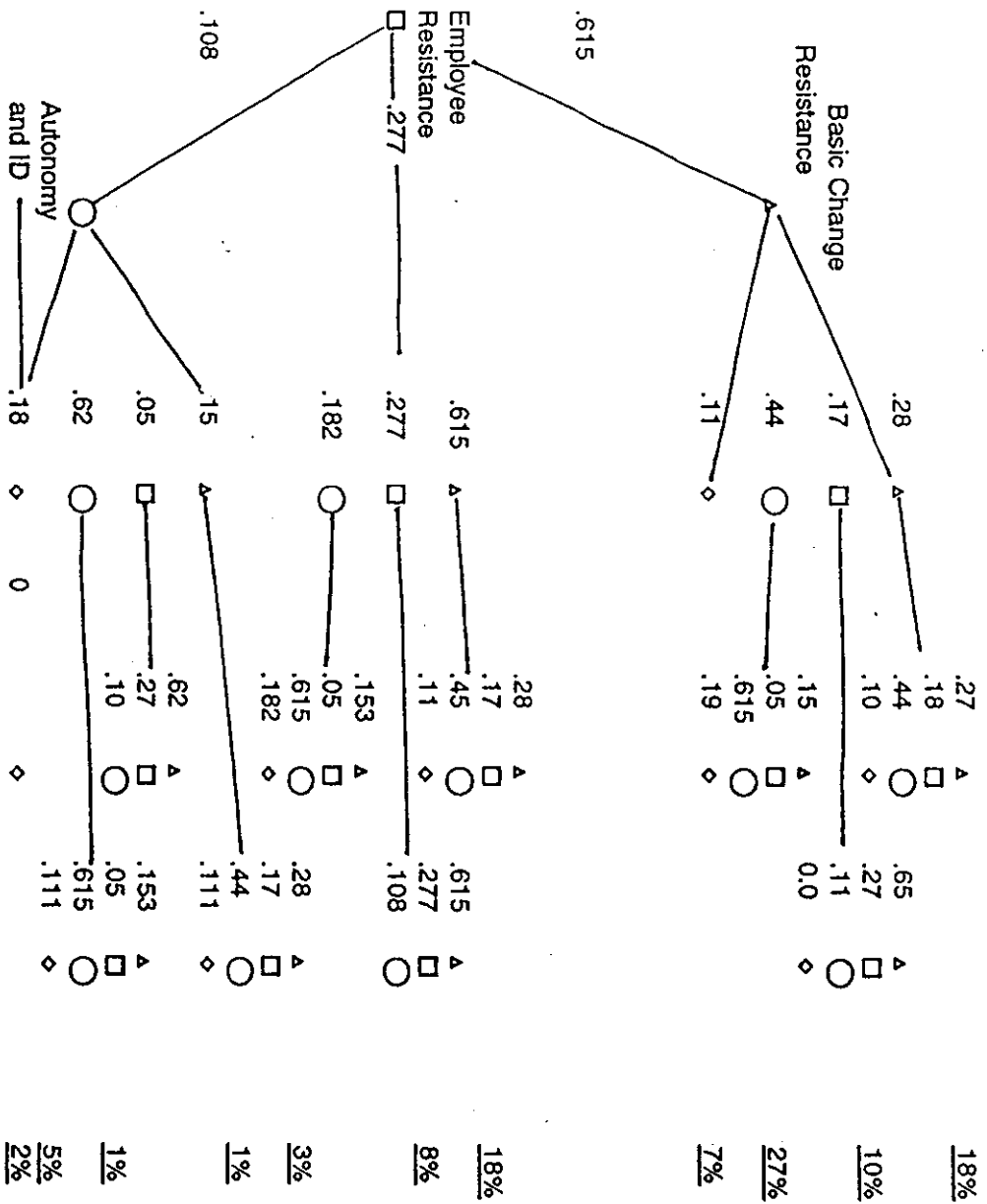
consolidation effort in a very deliberate and pre-planned manner.

The management of consolidation efforts should involve the employees at a very early stage and gain their commitment to the proposed reorganization. Effective change management techniques must be followed throughout. A great deal of time and effort must be spent on overcoming issues of autonomy/identity among the consolidating partners. It would appear from the data that if these two steps can be effectively managed in this order, that success should follow.

It is also recommended that future research be conducted, the scope of which is not limited to successful consolidation efforts, but specifically to unsuccessful consolidation efforts to determine what processes lead to failure as opposed to success.

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APPENDIX "A" - MARKOVIAN DECISION TREE

Basic Change
Resistance

.28
.17
.44
.11

Employee
Resistance

.615
.108
.277

Autonomy
and ID

.18
.62
.05
.15

.277
.182
.615

.277
.45
.11

.28
.17

.153
.05
.615
.182

.62
.27
.10

.18
.62
.05
.15

.27
.18
.44
.10

.15
.05
.615
.19

.11
.65
.27
.0.0

.615
.277
.108

.44
.17
.28

.111
.153
.05
.615
.111

0

18%
10%
27%
7%

18%
8%

3%
1%
1%

5%
2%

△ = Basic Resistance to Change
□ = Employee/Labor Resistance
○ = Autonomy/Identification Issues
◇ = Political/Inter-Jurisdictional Issues

APPENDIX "B"

TRANSITION MATRIX

	to	Emp.Res	Resis	Auton	IJ/Pol
from					
Employee Res		0.277	0.615	0.108	0
Resistance		0.167	0.278	0.444	0.111
Autonomy/ID		0.05	0.153	0.615	0.182
IJ/Politics		0	0	0	0

Survey of Consolidation Effort Process

1. What is the political form of your organization?:
   ☐ City   ☐ County   ☐ District   ☐ Other _____

2. What was the nature of your consolidation effort?:

   ☐ Total Consolidation   ☐ Multiple Agency Consolidation

   ☐ Functional Consolidation   ☐ Other _____

3. Identify which of the following obstacles or stressors you experienced in your Consolidation Effort:

   ☐ Employee/Labor Issues   ☐ Desire to maintain Autonomy

   ☐ Basic Resistance to Change   ☐ Political/Inter-jurisdictional Issues

   ☐ Other _____

4. In what order did you experience these obstacles (1 = first):

   ____ Employee/Labor Issues

   ____ Basic Resistance to Change

   ____ Desire to maintain Autonomy

   ____ Political/Interjurisdictional

   ____ Other_____

   ____ Other _____

   ____ Other_____

5. Did the effort "stall" out or remain fixed at one particular point in the process? If so, reflect the order of experience with consecutive numbers. (e.g. if the effort stagnated on "Employee Issues" and this was the third development, rate it as #3 and #4)

___ Employee/Labor Issues

___ Basic Resistance to Change

___ Desire to maintain Autonomy

___ Political/Interjurisdictional

___ Other_____

___ Other _____

___ Other_____

Thank you for your participation in this study. Please return this questionnaire in that attached, self-addressed, stamped envelope. If you have any questions regarding this study, they may be addressed to the author at 619-461-6101.

CONTROL #:_____