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Use of Decision Analysis in Arson Program Planning

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Fire Research
Washington, DC 20234

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Prepared for:
U.S. Fire Administration
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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, ***Secretary***
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, ***Director***

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USE OF DECISION ANALYSIS IN ARSON PROGRAM PLANNING

S. Wayne Stiefel

Abstract

A decision analysis approach is formulated and demonstrated to provide a planning tool for decision makers in a city or community concerned with selection and application of arson strategies. The Arson Information Management System (AIMS) is used to provide information to describe the arson problem (classify causes/motivation, incidence and magnitude for each area in the city/community) and to establish which strategies are appropriate to address the causes. This AIMS data plus an assessment of the cost and effectiveness of arson strategies are combined in a decision analysis framework. The framework specifies data requirements and provides a data analysis structure. The decision analysis has been designed to provide a measure of the net benefits for various strategies for each area in the city/community. A method for using the outputs from the decision analysis to provide the most cost-effective use of an arson budget has been developed.

Key Words: Arson; Arson Information Management System (AIMS); program management; cost benefit analysis; decision analysis.

1. INTRODUCTION

1.1 Background

As more information is accumulated regarding the types of arson fires and how they are distributed within a city or community, more guidance is possible for application of specific strategies intended to reduce the incidence and cost of arson fires. The Federal Emergency Management Agency (FEMA) has funded seven Arson Information Management System (AIMS) programs with community, fire and enforcement agencies. These pilot AIMS programs were intended to indicate the extent to which systematic collection and analysis of pertinent data can be used to improve arson prevention, control and enforcement efforts [1][1]. As an initial step in gaining understanding, AIMS data has been used to describe the arson problem by providing information measuring arson's magnitude and characterizing arson in terms of its location and motivation. Once such a description of the arson problem within a jurisdiction is obtained, strategies can be devised to address causes and direct intervention at high incident locations.

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[1]Numbers in brackets indicate literature references at the end of this report.

1.2 Objective

It is the objective of this report to provide a planning tool for decision makers in a city or community for selection and application of cost-effective arson intervention strategies targeted at high arson areas.

1.3 Approach

In the approach followed in this report, AIMS data are used to describe the arson problem (classify causes/motivation, incidence and magnitude for each area in the city/community) and establish which strategies are appropriate to address the causes. This AIMS data plus an assessment of the cost and effectiveness of arson strategies are combined in a decision analysis framework. The decision analysis has been designed to provide a measure of the net benefits for various strategies for each area in the city/community. A method for using the outputs from the decision analysis to provide the most cost-effective use of an arson budget has been developed. Figure 1 is a flow chart illustrating the approach.

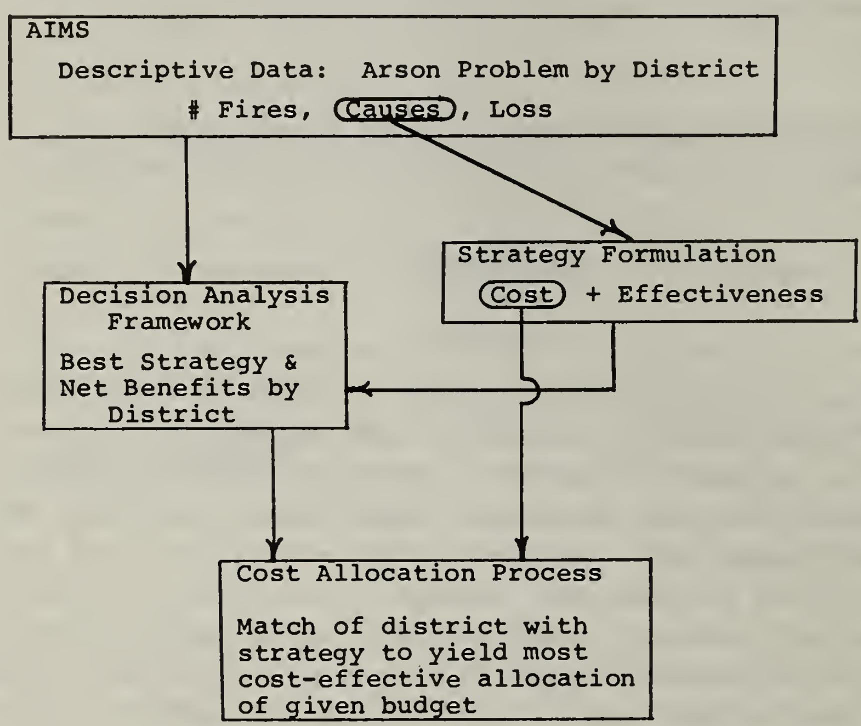

Figure 1. Flow Chart for Application of Decision Analysis to Arson Programs

In order to facilitate the explanation of this approach, a hypothetical set of data has been developed and is used for illustration throughout the discussion.

2. DECISION ANALYSIS

2.1 Description and General Applicability

Decision analysis in general involves modeling of the system being impacted by the decision. Decision analysis is applied to problems where cause and effect of the various available actions are unclear and intuitive judgements might prove incorrect. It also is applied when the complexity of interactions and the uncertainties (inherent in the evaluation of strategies) makes choice difficult. Decision analysis allows choice among strategies to be based upon systematic consideration of benefits, risks and costs. The process explicitly identifies factors which are considered important and shows where subjective judgements are incorporated, as well as their likely influence.

Decision analysis is a formalized approach for assisting decision makers under uncertainty [2]. It is the result of combining systems analysis with statistical decision theory. The systems analysis structures the problem so that it can be treated as a unified entity, while probability assessment is used to treat uncertainty. Decision analysis provides the decision maker with a cause and effect model which suggests the likely consequences of a selected course of action.

Since uncertainty is usually the focus for most significant decisions, decision making requires emphasis on uncertainty. If it is known for certain what outcome will result from the alternatives available most decisions become trivial. However, because there are many unknowns involved in most complex problems, the formal recognition and treatment of uncertainty aids the decision maker in structuring the bounds of the problem and determining what additional information may be worth gathering.

Decision analysis also requires the explicit understanding of values, trade offs between monetary and nonmonetary values. The trade-off between property and injuries or deaths is a typical value problem facing decision makers in fire protection.

Decision analysis goes beyond just revealing the decision. An important benefit of decision analysis is the understanding gained from the decision making process. Often, through examination of the logical structure, sources of information, or values used in making decisions; new insights are gained or avenues for communication are opened. It permits efforts to address information gaps or differences in values.

2.2 Applicability of Decision Analysis for Arson Program Management

Decision analysis was selected for application to provide an evaluation framework for choosing among alternative arson reduction strategies. The decision analysis methodology is intended to provide management with the tools necessary to evaluate the magnitude and nature of the arson problem and to employ cost beneficial strategies. Decision analysis has been successfully applied to other fire safety problems involving uncertainty[2]. An initial step in the formulation of a decision analysis framework consists of understanding the many complex interactions which lead to various outcomes. In this discussion the focus is on establishing the link between arson reduction strategies and arson fires. Therefore, a logical structure was developed which includes selection of a strategy and an implementation location and measures the expected outcome. Data requirements were established based upon the dictates of the logical structure. The following section provides, through example, the details of the decision analysis methodology.

3. EXAMPLE OF METHOD

3.1 Data Development

Descriptive data for each area in the city or community are developed from the AIMS. The descriptive data required would classify by arson type the number of fires and losses (property, injury and deaths) for each area of the city or community. Table 1 provides an hypothetical example of a data set for one city district.

Table 1. Arson Fire Descriptive Data for District 1

Arson Type*	Number of Fires	Property Loss (1000 dollars)	Deaths	Injuries
Juvenile (vandalism)	10	20	0	2
Arson-for-profit	5	150	0	4
Revenge	2	15	1	3
Pyromania	3	15	0	1
Crime Concealment	2	20	0	0

*Arson types correspond to data classifications reported by FEMA [3].

[2]Applications include upholstered furniture fire safety, marine fire safety and electric transformer fluids fire safety. See for example, Helzer, S.G., et al, Decision Analysis of Strategies for Reducing Upholstered Furniture Fire Losses, Natl Bur Stand, NBS-TN 1101 (June 1979). Current efforts at NBS are addressing the application of alternatives to reduce residential fire losses.

Over time, specific arson prevention and enforcement strategies have evolved, which have proven to be effective in reducing the arson problem. Table 2 illustrates, by arson type, specific actions intended to reduce the arson incidence [4].

Table 2. Prevention and Enforcement Actions Targeted at Specific Arson Types

Arson Type	Action
Juvenile	Counseling, public education Examine juvenile record, Interviews
Arson-for-Profit	Identify high risk properties Publicize, prevent over insurance Arson patrols, collect data Compare arson methods, Interviews
Revenge	Community-based dispute resolution service, Counseling - Investigative methods parallel assault or homocide
Pyromania	Screening individuals - maintain files - immediate canvassing of witness Counseling/treatment
Crime Concealment	General crime prevention methods Train fire departments and police to recognize signs

Having developed the descriptive data for the entire city, patterns of arson types may become evident through examination of the data. Depending upon the patterns and mix of arson types, strategies comprised of a one or more of the actions described in table 2 are developed. It is not necessary that the process lead to the selection of one strategy which will be applied throughout the entire city or community. Rather, a given strategy may apply to several districts with other strategies developed to deal with different arson types in other districts. The technique presented in this paper will allow for determination, within budget constraints, of which strategy to apply in each district. For this illustration three strategies have been developed. Strategy A employs the actions aimed at juvenile, revenge and pyromania caused arson. Strategy B concentrates on the arson-for-profit motive and Strategy C is a broad based approach aimed at the juvenile, arson-for-profit, revenge and pyromania caused arson fires, but at a lower level of effort for each motive than Strategy A or Strategy B.

Having defined a set of strategies, the next step concerns estimating their expected effectiveness in ameliorating each type of arson at the level of resources which will be expended. Strategy effectiveness is uncertain; however past experience provided by officials within your jurisdiction, review of additional AIMS information, or contact with officials in jurisdictions having applied similar strategies may provide data or judgements for assessing expected effectiveness. One procedure which has been widely applied for obtaining expert judgements in the absence of reliable data is the Delphi technique [5]. Table 3 provides the strategy effectiveness matrix for our hypothetical example.

Table 3. Strategy Effectiveness

Arson Type	Percentage Reduction Expected		
	Strategy A	Strategy B	Strategy C
Juvenile (vandalism)	30	2	15
Arson-for-Profit	0	35	15
Revenge	10	0	8
Pyromania	15	0	7
Crime Concealment	2	0	1

Table 4 provides the cost data for each strategy. Each strategy has fixed cost consisting of a minimum staff and resources necessary to administer the program, keep records, conduct various operations, etc. Also, for each district or area where the strategy is applied additional costs are incurred, which pertain solely to the implementation of the strategy within that district. These are the variable costs associated with the strategy. The total cost is the sum of the fixed cost plus the variable cost for each district where the strategy is to be applied.

Table 4. Strategy Cost Data

Location	Variable Cost (1000 dollars)		
	Strategy A	Strategy B	Strategy C
District 1	15	20	18
District 2	20	25	23
District 3	12	15	14
District 4	15	20	17
District 5	10	15	13
	Fixed Cost (1000 dollars)		
	Strategy A	Strategy B	Strategy C
City Wide	50	75	100
TOTAL PROGRAM	122	170	185

Having collected the information providing descriptive data by district; selected candidate arson strategies, and estimated their effectiveness and cost, all the data inputs are available to exercise the decision analysis model. The following discussion will explain how to utilize these data inputs to compute net benefits.

3.2 Decision Analysis Application

3.2.1 Rationale

The net benefit for implementation of a strategy can be computed simply as the difference in the arson losses without and with the strategy minus the cost of implementation. The outputs from the decision analysis are the expected outcomes (cost plus loss) measured in terms of the cost for strategy implementation and the loss or consequence of arson measured by the expected number and severity (property loss, injuries and deaths) of the fires. Each strategy is evaluated in every district being considered.

3.2.2 Explanation of Inputs to Decision Analysis

Figure 2 is a representation of the decision analysis framework. The symbols in the rectangular boxes in figure 2 are computed values. The computations will be explained later in this section. The remaining symbols are values which are provided as inputs to figure 2 from the tables previously described. The derivation of each input value will be illustrated using our hypothetical example. The outcome measures (property loss, injuries and deaths) in figure 2 are determined on a per fire basis. These values will apply for each strategy, since it is assumed that once a fire occurs its consequence is not influenced by the strategy in effect. Table 5 shows the computation of the outcome measures from table 1 on a per fire basis. These values can be used directly in the decision analysis and carried through in terms of property loss (dollars), deaths and injuries. This approach does not, however, avoid the difficult task of balancing dollars against life safety. Instead, this difficult and somewhat controversial task is shifted from the analyst to the decision maker.

Table 5. Expected Loss Per Fire for District 1

Arson Type	Property Loss/ Fire (1000 dollars)	Deaths/ Fire	Injuries/ Fire	Total Loss*/ Fire (1000 dollars)
Juvenile (vandalism)	2.0	0	0.2	6.0
Arson-for-profit	30.0	0	0.8	46.0
Revenge	7.5	0.5	1.5	287.5
Pyromania	5.0	0	0.3	11.0
Crime Concealment	10.0	0	0	10.0

*Total loss/fire measures are computed using a value of $20,000/injury and $500,000/death

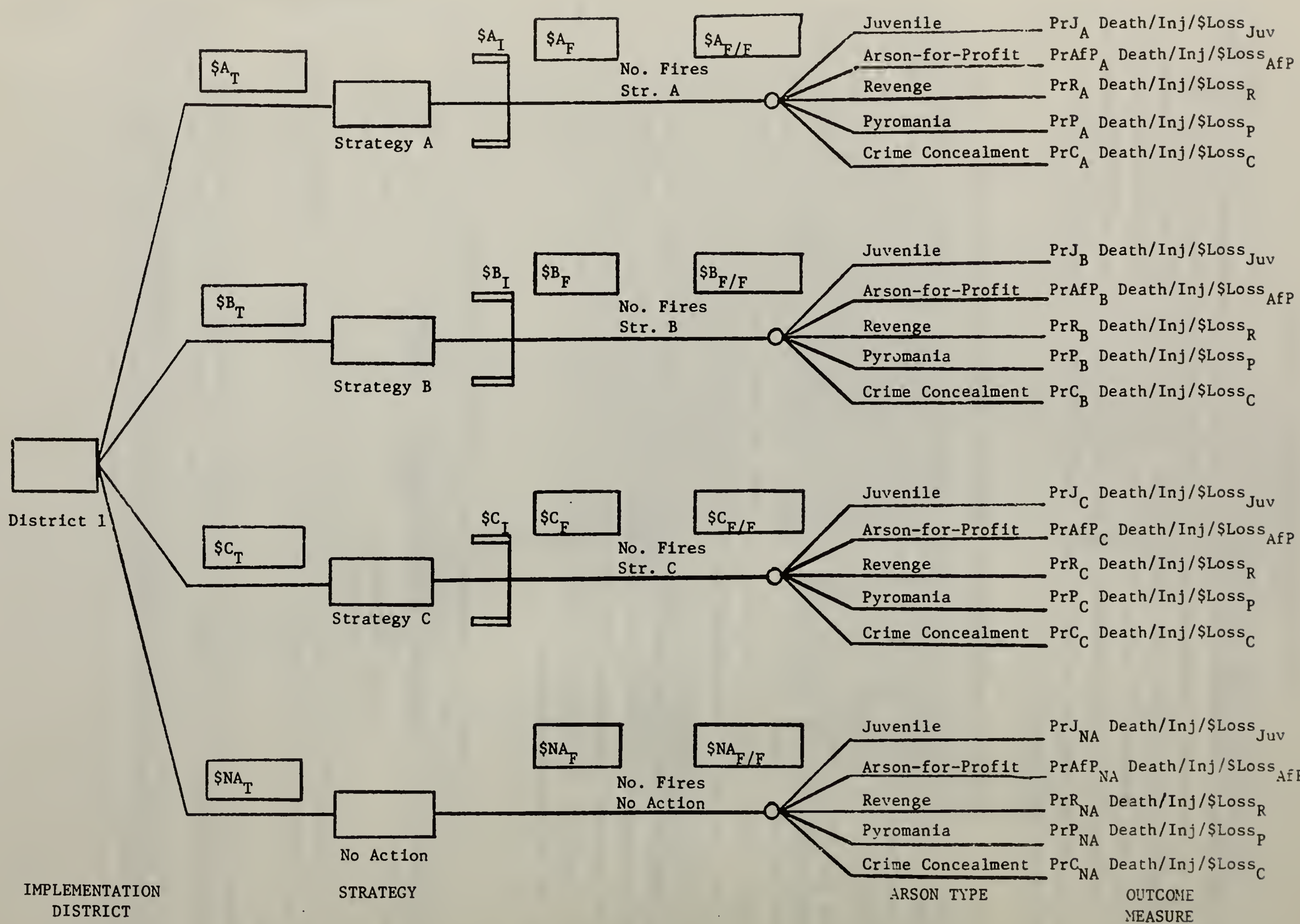

Figure 2. Arson Loss Model

The approach taken in this paper is to assign monetary value to lives saved and injuries avoided. This approach has the advantage that it measures all the benefits from arson strategies in the same units-dollars-which facilitates comparisons. The assignment of a monetary value, however, does raise practical and philosophical questions. A more indepth discussion can be found in the references [6, 7, 8]. For this example we have arbitrarily chosen to use a value of $500,000 for a life saved and $20,000 for an injury avoided.

The probability that an arson fire will be caused by a specific arson type is also an input to figure 2. It can be determined by dividing the number of fires caused by a specific arson type by the total arson fires expected for that strategy. For example, from table 1 the probability that an arson fire will be caused by a juvenile (PrJ_{na}) for the no action case equals the number of juvenile fires (10) divided by the total arson fires (22) or 0.45. Therefore, to determine similar probabilities for each arson type under each strategy requires estimation of the expected number of fires by arson type for each strategy (designated in figure 2 as No. Fires Str. A for strategy A). Such estimates can be made using the information in table 1; which applies to the no action case, and table 3, which provides the means to adjust the no action fire incidence based on strategy effectiveness. Table 6 merges tables 1 and 3 to estimate the number of expected fires for each strategy. Table 7 indicates the probability that an arson fire will be attributable to a specific arson type for each of the strategies. This computation is made from table 6 by summing the fires for each strategy and dividing this sum into each of the arson type fire totals.

One additional input value for the decision analysis (figure 2) requires explanation, that is, the cost for implementating the strategy in the district. Only the variable costs are used in the analysis and are depicted on figure 2 as $\$A_I$ to indicate in this case cost to implement Strategy A. For our example, these values are taken from table 4. The fixed cost for each strategy will be taken into account at a later stage, when it is shown how to allocate the budget.

3.2.3 Explanation of Computations for Decision Analysis

The symbols shown in rectangular boxes in figure 2 are computed values. The computations are made as follows.

$\$A_{F/F}$ which equals the expected loss per fire under Strategy A is computed by summing the products of the probability of specific arson types (see table 7) and the expected outcome of the arson type (see table 5).

In our example from figure 2,

$$\$A_{F/F} = \sum_{AT_i = Juv}^{\text{Crime Conc.}} Pr\ AT_{Ai} \quad OA_{Ti}$$

Table 6. Expected Fires for Each Strategy in District 1

Arson Type	No Action	Strategy A		Strategy B		Strategy C	
	(1) # Fires Table 1	(2) Expected Reduction Table 3	(3) (1)-(2)(1) # Fires	(4) Expected Reduction Table 3	(5) (1)-(4)(1) # Fires	(6) Expected Reduction Table 3	(7) (1)-(6)(1) # Fires
Juvenile (vandalism)	10.0	.30	7.0	.02	9.8	.15	8.5
Arson-for-Profit	5.0	0	5.0	.35	3.25	.15	4.25
Revenge	2.0	.10	1.8	0	2.0	.08	1.84
Pyromania	3.0	.15	2.55	0	3.0	.07	2.79
Crime Concealment	2.0	.02	1.96	0	2.0	.01	1.98
Total Fires	22.0	--	18.31	--	20.05	--	19.36

Table 7. Probability of Arson Fire by Specific Type for Each Strategy in District 1

Arson Type	No Action		Strategy A		Strategy B		Strategy C	
	Fires	Probability	Fires	Pr	Fires	Pr	Fires	Pr
Juvenile (vandalism)	10	0.45*	7.0	0.38	9.8	0.49	8.5	0.44
Arson-for-Profit	5	0.23	5.0	0.27	3.25	0.16	4.25	0.22
Revenge	2	0.09	1.8	0.10	2.0	0.10	1.84	0.10
Pyromania	3	0.14	2.55	0.14	3.0	0.15	2.79	0.14
Crime Concealment	2	0.09	1.96	0.11	2.0	0.10	1.98	0.10
Total Fires	22.0		18.31		20.05		19.36	

*Probability of a juvenile type fire under the no action strategy (PrJna) equals 10 ÷ 22 or 0.45.

where, $Pr\ AT_{Ai}$ is the probability that an arson fire is caused by a specific type of arson under Strategy A and OA_{Ti} is the expected outcome from a specific type of arson fire.

Expanding the expression in notation form

$$\$A_{F/F} = Pr\ J_A \cdot O_j + Pr\ AfP_A \cdot O_{AfP} + Pr\ R_A \cdot O_r + Pr\ Py_A \cdot O_{Py} + Pr\ C_A \cdot O_c$$

$$= 0.38\ (\$6.0) + 0.27\ (\$46.0) + 0.10\ (\$287.5) + 0.14\ (\$11.0) + 0.11\ (\$10.0)$$

$$\$A_{F/F} = \$46.09$$

$\$A_F$ which equals the expected loss for all arson fires under Strategy A is the product of $\$A_{F/F}$ and No. Fires Str. A. For our example:

$$\$A_F = \$A_{F/F} \cdot \text{No. Fires Str. A}$$
$$= \$46.09\ (18.31)$$
$$\$A_F = \$843.91$$

$\$A_T$ is the sum of the variable cost for implementing Strategy A and the expected loss under Strategy A. It is the sum of $\$A_I$ and $\$A_F$, where $\$A_I$ is the variable cost for implementing Strategy A (see table 4). For our example:

$$\$A_T = \$A_I + \$A_F$$
$$= \$15 + \$843.9$$
$$\$A_T = \$858.9$$

Completing, the computations for each strategy in district 1 yields the decision tree shown in figure 3.

It is now possible to compute the net benefits for each of the strategies. The net benefit for a strategy is simply the difference between the losses incurred for the no action case and the cost plus loss for that strategy. Table 8 summarizes the output from figure 3 and indicates net benefit for each strategy[3].

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[3]At this point we have not included fixed cost in the net benefit figures.

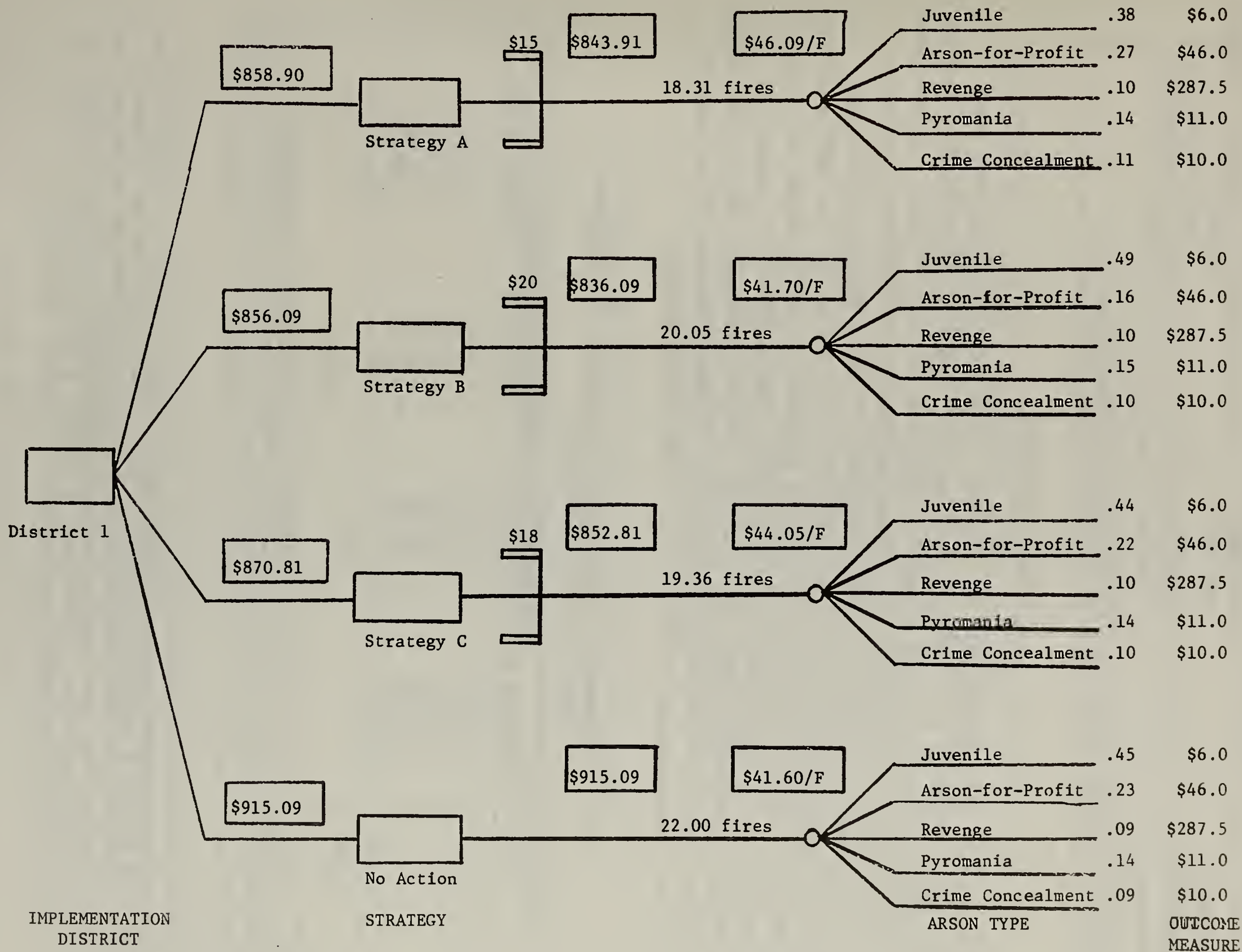

Figure 3. Arson Loss Model for District 1

Table 8. Summary of Cost plus Loss and Net Benefit for District 1

Strategy	Cost plus Loss* ($1000)	Net Benefit* ($1000)
No Action	915.09	0
Strategy A	858.90	56.19
Strategy B	856.09	79.00
Strategy C	870.81	62.28

*Does not include fixed cost for strategy implementation

4. BUDGET ALLOCATION

This section will demonstrate an approach for selection of the most cost-effective arson strategy for a given budget amount. Using our hypothetical example again, suppose we have completed a decision analysis for each of the five districts under consideration. The results from these analyses are summarized in table 9. Table 9 has a column for each of the Strategies A, B and C plus an additional column for a combination of Strategies A and B. We can consider the combination of Strategies A and B since they are directed at different types of arson and there is no program overlap[4]. The fixed cost for strategy implementation is taken into consideration in computing total net benefits. Table 9 indicates that if our total program budget were $170,000 we would derive our highest estimate of net benefit ($224,000) by implementation of Strategy B in all five districts.

Table 9. Summary of Estimated Net Benefits and Program Costs for Arson Strategies

	Estimated Net Benefit (1000 dollars)			
	Strategy A	Strategy B	Strategy C	Strategy A&B
District 1	56.19	79.00	62.28	79.00
2	68.30	65.82	75.85	68.30
3	42.34	53.40	55.81	53.40
4	35.42	25.50	38.61	35.42
5	58.32	75.46	65.34	75.46
Fixed Cost St A	-50.			-50.
St B		-75.		-75.
St C			-100.	
Total Net Benefit ($1000)	210.57	224.18	197.89	186.58
Total Program Cost ($1000)	122.	170.	185.	292.

[4]Combining Strategy C with either Strategy A or B and using the net benefit values derived from figure 3 would be incorrect. This relates back to the estimation of strategy effectiveness (see table 3) and the arson fire reduction expected. The reduction expected for each arson type is dependent upon the level of effort and is not necessarily additive. Therefore, a program strategy with a new level of resources directed at an arson type requires a separate evaluation.

Suppose our budget is restricted to $125,000, what can we learn from our analyses? Let's consider each strategy and limit the implementation in districts according to the net benefit derived for the funds expended. Rank ordering districts according to net benefit provides an easy method for searching for the greatest net benefit. Taking the strategies one at a time indicates the following.

Strategy A - Since the total program cost for Strategy A is $122,000, it is an acceptable program within our $125,000 budget limitation. The estimated net benefit for Strategy A is $211,000. In addition, there is a budget surplus of $3,000.

Strategy B - Since we are seeking the net benefit derivable from our $125,000 budget, table 10 rank orders the districts in terms of their net benefit. Also, cumulative costs are indicated. The initial entry of fixed cost in table 10 indicates that prior to deriving any benefits the administrative structure must be in place. Adding districts one at a time, we see that the addition of district 2 causes us to exceed our budget limitation. However, by substituting district 3 we remain within the budget constraint and achieve our greatest net benefit for Strategy B. An estimated net benefit value of $133,000 is achieved by implementing Strategy B in districts 1, 3 and 5, after subtracting Strategy B's fixed cost.

Table 10. Rank Order of Districts for Strategy B According to Net Benefit Estimates

	Net Benefit ($1000)	Cost ($1000)	Cumulative Cost ($1000)
Fixed Cost		75	75
District 1	79.00	20	95
District 5	75.46	15	110
~~District 2~~	~~65.82~~	~~25~~	~~135~~
District 3	53.40	15	125

Total Net Benefit: $207.9K - $75K = $132.9K
Total Program Cost: $125K

Strategy C - Table 11 indicates the results from rank ordering districts for Strategy C. The relatively high fixed cost of $100,000 restricts us to implementing Strategy C in district 2 only for an estimated net loss of $24,000.

Table 11. Rank Order of Districts for Strategy C According to Net Benefit Estimates

	Net Benefit ($1000)	Cost ($1000)	Cumulative Cost ($1000)
Fixed Cost		$100	$100
District 2	75.85	23	$123

Total Net Benefit: $75.9K - $100K = -$24.1K
Total Program Cost: $123K

Strategy A and Strategy B - The combined <u>fixed</u> cost for Strategy A and Strategy B of $125,000 equals our budget limitation. Therefore, this combination of strategies is not a feasible approach.

The results from the hypothetical example indicate that Strategy A yields the greatest estimated net benefit of $211,000 with an expenditure of $122,000. Strategy B's implementation in districts 1, 3 and 5 achieves an estimated net benefit of $133,000 while expending the full $125,000 budget. If the analysis indicated small differences in net benefits between strategies, the decision for selection could be made perhaps using other factors not considered in the analysis. The analysis provides the knowledge that the net benefit to the community will not be significantly altered with the implementation of either strategy.

Often, after the results of an analysis are presented, many questions are raised concerning assumptions or values used in the analysis. Care must be exercised when one factor appears to dominate the results of an analysis in an undesired manner. For example, if one death has been noted and it dramatically shifts the decision to a particular strategy; a question should be raised if this event can be expected on a regular basis or was a fluke caused by unusual circumstances. To determine how significant a change would take place in the results the analysis can be repeated removing the event under question from the input data. This process of systematic variation of inputs and notation of resulting changes is known as sensitivity analysis.

The application of sensitivity analysis serves to answer many of the "what if" questions often raised after completing an analysis. For example, what if:

(1) the monetary value used for lives saved and injuries avoided were significantly more or less,

(2) strategy effectiveness values were different, or

(3) a larger or smaller budget allocation were available?

This opening up of the communication process, addressing key issues of importance to the community, is one of the most important benefits resulting from a good analysis.

5. SUMMARY

This report has demonstrated an approach which uses AIMS data to characterize the arson problem and thereby establish the basis to formulate candidate arson reduction strategies. Using example data the decision analysis framework was presented and exercised to estimate strategy net benefits, through the combination of the AIMS data with assessments for the cost and effectiveness of the arson strategies. The net benefits were estimated for application of the candidate strategies in each area in the city or community. The most cost-effective arson strategy for a given budget was selected, based upon a procedure which rank orders districts by net benefit and accounts for cummulative strategy implementation costs.

The decision analysis framework can be used to select among arson program strategies within a single district or, as demonstrated, across a community. The procedure specifies data requirements and provides a data analysis structure. By specifying data requirements, needed data can be collected and where data gaps exist considered judgements can be substituted. The data presented in this discussion were developed only to serve our hypothetical example. To utilize the described methods each city/community will have to develop their own data set.

The decision analysis process serves to open up communication on important assumptions and values used in the analysis. Sensitivity analysis can be used to answer the "what if" questions often raised following completion of a good analysis.

6. ACKNOWLEDGEMENT

The author would like to acknowledge gratefully the assistance of Alan Gomberg, whose insights and feedback contributed greatly during preparation of this report.

7. REFERENCES

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WASHINGTON, D.C. 20234

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U.S. Fire Administration
Federal Emergency Management Agency
Washington, D.C. 20472

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

A decision analysis approach is formulated and demonstrated to provide a planning tool for decision makers in a city or community concerned with selection and application of arson strategies. The Arson Information Management System (AIMS) is used to provide information to describe the arson problem (classify causes/motivation, incidence and magnitude for each area in the city/community) and to establish which strategies are appropriate to address the causes. This AIMS data plus an assessment of the cost and effectiveness of arson strategies are combined in a decision analysis framework. The framework specifies data requirements and provides a data analysis structure. The decision analysis has been designed to provide a measure of the net benefits for various strategies for each area in the city/community. A method for using the outputs from the decision analysis to provide the most cost-effective use of an arson budget has been developed.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

Arson; Arson Information Management System (AIMS); program management; cost benefit analysis; decision analysis.

13. AVAILABILITY

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