

DEVELOPING A MATHEMATICAL MODEL FOR CRISIS MANAGEMENT AND STRATEGY DESIGN

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ABSTRACT

This paper is considering the issue of crisis management and related strategy design with a cost minimizing approach. In this paper, a mathematical decision making model is presented for crisis management and preventive costs are considered besides the crisis event costs. Following the mathematical model, desirable procedure for developing and performing a crisis management strategy is presented according to related costs. Future research areas are discussed in final section.

Keywords: *Crisis Management, Strategic Management, Mathematical Optimization*

INTRODUCTION

Traditional approach to crisis management believed that crisis management means to shut the fire. They wait for a problem to happen and after the occurrence of failure they try to limit the related costs. But, recently the crisis management approach is changed. According to recent approach, a set of practical plans must be ready in organizations ever to encounter the probable future problems. And managers must think about the probable future events and be ready to solve the unpredicted crisis occurrences. Crisis is an accident, event or a process which keeps the organization away from its regular performance or delays the implementation of activities, missions and achieving the goals of system. Generally, the crisis can be categorized to two sets of natural disasters such as earthquake, flood etc.: and unnatural crisis such as war, political tension etc.: In a systematic point of view, crisis is a situation which the discipline of whole original system or parts of it (subsystems) is disturbed or its stability is unsettled. As a summary, we can define crisis as follows: fragmentation which affects the system physically and threatens the basic assumptions, sense of mental existence and critical basis of system's way of life (Pauchant and Mitroff, 1992). In defining the organizational crisis it is better to make difference between crisis and disaster. Crisis is referred to a condition, which the basis of problem can be issues like structures, inappropriate managerial activities or a failure in a change adaptation. On the other hand, disaster is referred to a condition that company encounters with unpredicted or sudden catastrophic changes, which has a little control on them (Ritchie, 2003). Although, there are some differences between various definitions of crisis, all these definition are common in three factors of threat for organization, shock, and very little time for decision making. Lack of a comprehensive point of view to the concept of crisis can be attributed to the multifaceted nature of that. Different psychic factors, political-social factors and structural-technological factors have an important role in understanding the concept of crisis phenomenon and its proper management (Pauchant and Douvill, 1994). From the subject point of view, performed studies related to crisis can be categorized to its four basic essential aspects, which are: 1- Reasons of occurrence. 2- Outcomes. 3- Preventive cautionary actions. 4- After crisis activities (Pearson and Clair, 1998). After the occurrence of crisis there are two main activities that must be done: the first one is determination of crisis causes for future preventive actions and the second one is making a linkage with stakeholders to notify them about the results and effects of the current crisis (Rudolph, 1986).

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The concept of crisis can be considered as a deviation from the general balance of organization relation with its environment or a definition of environmental characteristics that the organization has to be aware of that, continuously. In each of these two attitudes, holding the crisis issues in a strategic management framework is perceptible in the best way (Booth, 1993).

The idea of crisis management was firstly introduced by Robert McNamara when there was a probability of missile war between USA and Cuba. At the end of 1970s the concept of crisis management was employed in the current framework. Crisis management is a process to prevent the crisis or minimize its outcomes during the occurrence time. In order to handle this process it is needed to have plans for the worst probable situations and finding appropriate solutions for these situations. The procedure of crisis management includes three steps: before crisis, during the occurrence and after crisis. The method that is selected by the senior manager of organization in order to confronting crisis is an important part of organization whole strategy (Johnson and Svholes, 1988).

Occurrence of some crisis is inevitable despite of every preventive arrangement. So, it is not possible to eliminate the entire crises which threaten the organization, as the same is true for risks. Nevertheless, performing crisis management enables the organization to eliminate a part of crises, effectively manage the others and apply the needed tools for fast learning from the occurred crises. For this purpose, it seems that there is a need for modern abilities and skills that enables managers to transform the failure to success and irregularity to regularity. In other words, if the strategic management leads the organization to its goals on the basis of “Do’s”, crisis management focuses on “Don’ts” to smooth the moving path towards the organization goals.

Crisis management deals with tries that wants to identify the crisis-prone parts of the organization and predict the different kinds of crisis. It tries to prevent the occurrence of crisis or the events that result to crisis and minimize the effects of inevitable crises as it is possible, while strategic management deals with formulation, performance and evaluation of strategies which leads the organization to its goals.

Crisis management has a strategic nature and there is a close relation between strategic management and crisis management. Characteristics, similarities and trends of these two help to explain the relation between them. Occurrence of an organizational crisis can change the current strategy of organization and its strategic proceedings. On the other hand, without doing strategic actions in the area of crisis management, there is a higher probability of critical events occurrence. In this relation, crisis must be defined as any event that its occurrence will jeopardize the main goals of organization which is profit making and development (Rezvani, 2007).

There is a little attention to mathematical modeling and the costs of crisis occurrence in performed studies of crisis management. In this paper it is tried to define a strategy to minimize the system costs according to principals of crisis management. In section 2, parameters and mathematical model are presented. Section 3 is dedicated to appropriate strategic approach of the problem. Conclusions and possible future research areas are presented in section 4.

I. Decision making by mathematical model

It should be noted that important and key decisions are the most required issues of crisis management in first moments of occurrence. Not only these decisions affect in wide ranges of organization and make the future and scope of the crisis, but also they are judged by all the stakeholders of the organization. So, it is logical that making an appropriate decision in the crisis duration needs the categorization of facts and events. More than 90% of sensitive decisions are made in first hours of crisis and many factors about employees and issues of the organization must be considered in these decisions. The key problem complexity is here, because a main part of these required and simultaneous considerations can be performed in predictions and plans of crisis management before the occurrence of crisis.

Although, fast decision making is one of the prior and basic proceedings of crisis management, but the quality of decisions has a very important affect. Crisis is nothing except the interaction of factors that suddenly changed from the regular position to irregular position and have disrupted the peace of organization. Lack of experience and skill leads to making decisions based on incorrect judgments and

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unfounded understandings. Decision can be inferred as a system outcome that defines the values of that system.

Crisis management can be divided to two categories from a specific point of view: 1- Action-oriented category which is performed before the occurrence of crisis in order to prevent or minimize the damages. 2- Response-oriented category which is performed after the occurrence of crisis and aims to compensate the losses. It is notable that there is a little study performed in first category in order to predict the damages.

Although no crisis is exactly similar to the other one, there are some considerable similarities between different crises. In the presented model, these similarities are employed and system costs are estimated. As it is said, action-oriented category is related to the time before crisis occurrence and there is no exact data about the considered crisis. In Mathematics world, this lack of data is known as uncertainty and is surveyed by two approaches of fuzzy theory or probability theory.

Fuzzy theory is usable for the systems that do not have any previous data, so a function is defined for the system by using experts' opinion and decisions are made by this function. The procedure is different for the systems with previous data. In these systems it is possible to define a distribution for expected events according to previous data and solve the model by the distribution parameters. The approach of this article is to present a model for natural disasters. Studying existing data of occurred disasters shows that the expected number of disasters in each year and in a specific area follows a Poisson distribution, while for unnatural crises it is possible to have another distribution. According to above mentioned explanations, following notifications and mathematical model are presented:

1- Notifications

P_j :Probability of disaster J occurrence (We have n possible kinds of crises)

λ_{ji} :Number of people who needs the service i when the disaster j occurs

c_{ji} :Cost of creating service i before occurrence of disaster j for each person (We have m possible kinds of services)

d_{ji} :Percentage of people who needs service i in disaster j and can be served (Decision variable)

b_{ji} :Cost of not getting service i in disaster j for each person

P_{jk} : Probability of asset k to be damaged in disaster j (Asset can be a house)

μ_{jk} :Number of asset k that are in probable damage in disaster j (We have L possible kinds of assets)

h_{jk} :Cost of asset k damage in disaster j for each asset

e_{jk} :Cost of securing asset k against disaster j for each asset

x_{jk} : Is 1 if asset k is secured against disaster j, otherwise it is 0 (Decision variable)

β_{jk} :Number of people who are injured according to asset k damage in disaster j

g_{jk} :Cost of people injury according to asset k damage in disaster j for each person

Q :Maximum limit of financial damage that is allowed by system

S :Maximum limit of injury that is allowed by system

Z :Maximum limit of system budget for preventing the crisis

Using the above notifications we can present the model of cost minimization for managing the crisis. It is notable that the parameters of this model are extracted by probabilistic relations, each of which needs to solve related mathematical models. In this study the parameters are not calculated and just the optimized

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number of needed service i in disaster j (d_{ji}) and the optimized number of asset k that must be secured against disaster j (x_{jk}) are under consideration as the decision variable. Also, the monetary cost of injuries can be calculated by life insurance equivalents.

2- Mathematical Model

First phase of the objective function denotes the sum costs of creating service for $\lambda_{ji}c_{ji}$ people before the occurrence of disaster j . Second phrase denotes the costs of getting assets secured. Third phrase represents the financial and injury costs of each disaster with its related probability of occurrence. Constraint (1) denotes the costs of preventing, which has to be lower than system budget. Constraint (2) and (3) represent the maximum allowed costs of financial and life damages by the system. Constraint (4) and (5) shows the nature of decision variables.

$$\min f(x_{jk}, d_{ji}) = \sum_{j=1}^n \sum_{i=1}^m \lambda_{ji} d_{ji} c_{ji} + \sum_{j=1}^n \sum_{k=1}^l \mu_{jk} e_{jk} x_{jk} + \sum_{j=1}^n P_j \left\{ \sum_{i=1}^m \lambda_{ji} (1-d_{ji}) b_{ji} \right. \\ \left. + \sum_{k=1}^l (P_{jk} \mu_{jk} h_{jk} + \beta_{jk} g_{jk}) (1-x_{jk}) \right\}$$

$$S.t: \sum_{j=1}^n \left\{ \sum_{i=1}^m \lambda_{ji} d_{ji} c_{ji} + \sum_{k=1}^l \mu_{jk} e_{jk} x_{jk} \right\} \leq Z, \tag{1}$$

$$\sum_{j=1}^n \left\{ \sum_{i=1}^m \lambda_{ji} (1-d_{ji}) b_{ji} + \sum_{k=1}^l P_{jk} \mu_{jk} h_{jk} (1-x_{jk}) \right\} \leq Q, \tag{2}$$

$$\sum_{j=1}^n \sum_{k=1}^l \beta_{jk} g_{jk} (1-x_{jk}) \leq S, \tag{3}$$

$$x_{jk} = 0,1, \quad j = 1, \dots, n, \quad k = 1, \dots, l, \tag{4}$$

$$0 \leq d_{ji} \leq 1, \quad j = 1, \dots, n, \quad i = 1, \dots, m, \tag{5}$$

II. Strategic Approach

While financial performance is one of the most important goals of strategic management, adherents of crisis management add quality, security and reliability to the structure of goals. Strategic management tries to benefit stockholders, employees, investors, government institutions and customers as the main stakeholders of the organization, while the adherents of crisis management know the following issues as the basis of development: future generations, special stakeholder groups (such as environmentalists), local politicians, local competitors and socialism.

Generally, the organization managers ignore the management of emergency situations in defining strategies and organizational goals. In a few number of organizations, a plan is defined to hold the crisis beside the existing strategic plans (Rezvani, 2007).

The strategic management procedure is composed of three main steps: strategy formulation, strategy implementation and strategy evaluation (David, 1999).

But in many systems, these steps are implemented in comparative stability and certainty conditions, while the crisis condition is a completely irregular and shocking situation for the system. So, according to the numerical results of above mentioned mathematical model for each under studied system, it is possible to perform the following three steps of strategic management.

1- Strategy Formulation

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In most of the systems, financial performance is the dominant approach of decision making, but in government and nonprofit organizations this approach is replaced by human issues, and safety of human beings gets the priority of organization. In current study, where the natural disasters are under study, the priority is to save the human beings, but this is not completely possible and follows an enormous costs. So, according to the nature of system and the results of proposed mathematical model, system hazards can be categorized, and according to decision variables it is possible to define the system condition.

According to the current position of organization and its goal, which is to achieve a minimal financial and life costs, it is needed to define a 5 to 10 years plan. This plan must lead the financial and life costs of the system from the current position to the desired position with a smooth slope.

2- Strategy Implementation

After defining the strategy, it is the time to implement that. One of the important factors of success in implementing a strategy is the system structure and its adaptation with the defined strategy. So, it must be considered that the system must be reengineered due to the defined strategy. In current study the reengineering can be defined as training the personnel and a specific group of crisis management, and general announcements to reform the social behavior in crisis time.

The important issue that must be considered in cost approach is about resource assignment and specifically the financial resources. Due to the fact security and training are both money consuming, the organization must apply the approaches which hold the security and training in the shortest time by considering the probability of each kind of disasters. One of the most effective ways can be the usage of public training and media tools such as television, radio and newspapers which has a fast rate of spread in the society.

It is notable that each system desires to remain at its current situation and most of the systems resist against any changes, so managing this resistance is a main issue that must be considered in the process of strategy implementation. Using numerical results and presenting the benefits of using a predefined strategy in managing a crisis are the issues which can accompany the organization with defined strategy besides an appropriate training.

3- Strategy Evaluation

Implementing strategies needs to be evaluated to determine the success or defeat of them. Due to the fact that the disaster related strategies are not implemented in a routine manner and are defined for emergency conditions of the system, evaluating them is a more difficult process than the routine strategies of the organization. So, it is possible to use simulation techniques or preparedness exercises to evaluate the defined strategy, as the fact that in many countries there are several exercises to be ready for confronting disasters such as earthquake, flood, war, etc.: in each year.

The evaluation of crisis management strategies performance must be accomplished by comparing predefined indexes and in each simulation or exercise the resulting progress must be compared with the previous ones and the desired conditions. Using computer software, graphs and tables can present more tangible and accurate results and affect the process of fast decision making, which is one of the most basic principles of crisis management.

There may be some bugs in each exercise which may be the result of inappropriate strategy definition or implementation, and can be modified and redefined by using the results of simulated implementation of strategy. In current study, variations of damaging parameters and reducing their related costs can be appropriate criteria to evaluate the promotion and effectiveness of defined strategy.

Conclusions and Future Research

As it is obvious, organizations managers cannot manage all the kinds of crises in their system. However, if they believe crisis management as an inseparable part of their strategic management responsibility, the probability of having a crisis in their organization will decrease significantly. It is important to pay attention to crisis management and considering its relation to technical and practical planning, because the crisis management can ensure the longevity and development of an organization.

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As a future research, the proposed model can be extended for different probability distributions. Also, different mathematical and statistical approaches can be used to define the monetary value of human injuries in the model. It is obvious that there may be some other crisis expenses which are not presented in current study. Costs of training, mental effects of crisis, economical shocks and some other important costs can be considered to make the presented model more comprehensive.

REFERENCES

- Booth S (1993).** *Crisis Management Strategy* (Routledge) 64.
- David FR (1999).** *Strategic Management* (Prentice-Hall Inc) 7th.
- Johnson S and Svholes K (1988).** *Exploring Corporate Strategy* (Prentice-Hall) London.
- Pauchant T and Douvill R (1994).** *A Study of ۲۴* (Authors Publication), *Industrial and Environment Crisis Quarterly* (۷) ۴۳-۶۱.
- Pauchant T and Mitroff I (۱۹۹۲).** *Transforming the Crisis Prone Organization*, San Francisco, Gossey-Bass.
- Pearson CM and Clair JA (1998).** Reframing Crisis Management, *Academy of Management Review* (۲۳) ۵۹-۷۶.
- Rezvani HR (2007).** The Integration of Crisis Management in Organization Strategies, *Tadbir Magazine* 177 (In Persian).
- Ritchie BW (2003).** Chaos, Crises and Disasters: a strategic Approach to crisis Management in the Tourism Industry, *Tourism Management Journal*, University of Canberra, Australia 2.
- Rudolph B (1986).** Coping with catastrophe, *Time Journal* 53.