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Dynamic Simulation of the Group Behavior under Fire Accidents Based on System Dynamics

Jian SONG, Ming-guang ZHANG*, Feng ZHENG, Fu-zhen CHEN

Jiangsu Key Laboratory of Hazardous Chemicals Safety and Control, College of Safety Science and Engineering, Nanjing Tech University, Nanjing, 210009, China

Abstract

In order to study the group behavior under severe fire accidents in chemical industrial park, a model of the group behavior was built based on the epidemic model and the system dynamics (SD) theory and method. The influencing factors were selected through analysis of previous research. And taking the group behavior as the main research object, the causality relationships and model between the influencing factors were analyzed. On this basis, system dynamics software vensim was applied to finish dynamic simulation, then dealt with the influence of the group behavior in the change of government credibility, public sentiment and influence of events. The simulation results show that improving the government credibility would increase the public's satisfaction and trust to the government. At the same time, it is an important measure to deal with the group behavior by easing public sentiment and reducing influence of events. It provides a basis method for group behavior management related to fire accidents in chemical industrial park.

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1. Introduction

The establishment of chemical industrial park can optimize the enterprise resources and allocation of personnel. And it can promote the development of chemical industry economy. At present, chemical industry has been experienced rapid development with some beneficial policy implementations. The number of provincial chemical zone has reached more than 380 [1]. However, fire and explosion accidents occur frequently, and cause huge casualties and property damage. The harm caused by the accident can easily lead to public discussion, bring psychological damage and even cause group behavior, which has serious impact on social security and public living environment [2-3].

The group behavior under sudden crisis refers to the fact that the individual behavioral choice is the imitation of the public [4]. Rather than depending on the basis of their own information, the essence is that an individual is influenced by the behavioral strategy of others. In the fire accidents in chemical industrial park, the most important demand of people is the safety [5]. To ensure that they are not hurt or violated, different behavioral characteristics of the group will form a common goal and beliefs, and manifest group behavior. Group behavior spreads through the public, and the evolution of the population is consistent with the SIR epidemic model shown in Fig. 1. This epidemic model [6] divided the public into three parts: Susceptible (S), Infected (I) and Removed (R).

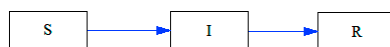


Fig. 1. The SIR model

* Corresponding author. Tel.: +86-13815892792.

E-mail address: mingguang_zhang@njtech.edu.cn

The new era of the Internet is growing rapidly. Once a fire accident happens, related reports will be reprinted in a short period of time, and form fire accidents group behavior with the development of reports. Besides, group behavior can be easily intense due to opaque government information, public excited sentiment and other reasons [7]. Therefore, how to deal with the propagation of group behavior is the main task for the government to control the group behavior under fire accidents.

Recently, many scholars conducted a continuous study for group behavior under the accident scene. He [8] built an emergency management system for accidents, which is based on ARCIMS; Li [9] selected a series of influence variables and used system dynamics simulation software vensim to build a personal risk bias dynamic system; Wang [10] carried out dynamic simulation and risk quantification of the chemical accidents risk from the aspects of the risk perception of the public groups; Li [11] studied the government measures and mechanism of the influence of personal sensitivity on the spread of public opinion in the public groups; She [12] established a mathematical model of infectious diseases to analyze the group behavior under fire accidents. At present, the research on the group behavior of fire and explosion accidents has more focuses on the theoretical aspect, and the quantitative research on the group behavior of fire and explosion accidents is less.

On account of the situation above, this paper combines the system dynamics (SD) theory and principles to study the influence mechanism of government, media, public and fire accidents on group behavior, and use system dynamics simulation software vensim to simulate and analyze the group behavior under the scenarios of fire accidents.

2. Construction of group behavior causal relationship

2.1. Analysis of influencing factors of group behaviour

The dynamic evolution system of the group behavior of fire accidents has its own complexity. The interaction between the factors is complicated in the evolution system. Each influencing factors interact each other [13-14]. Usually, fire accidents will cause public attention and discussion, and even lead to social panic due to the public and the sensitivity of the event [15]. In general, the group behavior often originated from the network media. The network media is particularly critical for the evolution of group behavior. The increase of media attention and public participation will directly accelerate the development of group behavior and push the group behavior to a new climax. At the same time, the government is an important force to control the group behavior, and ease the public sentiment. When the fire accident happens, the government always pay close attention to the development of the group behavior [16]. Besides, the official news will publish event information in time and response positively to weaken public sentiment, and reduce the group behavior.

In the initial stage of group behavior, there may be only a few words. With the continuous transformation of group behavior, the spread of group behavior will gradually develop into a fierce state. Therefore, in addition to the fire accidents and the public and sensitivity of event that drive the group behavior of the occurrence and spread, the external driving force would also promote the development of group behavior in the whole evolution of group behavior. The evolution process is based on internal and external driving forces, which have an impact on the social culture, public psychology, network order and government regulation and control. On the one hand, the fire accidents, public group and media will drive the development of group behavior; On the other hand, the government will manage and control the spread of the group behavior. Consequently, the group behavior of fire accidents in chemical industrial park can be composed of four parts: the government, the media, the public and the accident itself.

2.2. Main part of group behavior causal relationship

2.2.1. Fire accidents

The fire accidents usually lead to the public attention and discussion, and even cause social panic because of its greater impact. In the initial days of media discussion, there may be several words. As time goes on, the spread will gradually develop into a fierce state. The causality relationship of fire accidents is shown in Fig. 2.

(1) Public degree of events. Generally speaking, the greater the public degree of fire accidents is, the greater the scope of its impact is, so the social impact will be greater. The public degree of fire accidents is mainly determined by the correlation and non-selectivity of the fire accidents. The higher the value of the correlation and non-selectivity is, the greater the public degree will be [17].

(2) Sensitivity of events. The occurrence of group behavior generally comes from the accumulation of group contradictions. When the degree of accumulation triggered to the public sensitivity, the influence of event will increase, and will easily lead to intense affection.

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