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Analysis on the Transformation Intrinsic Mechanism and Coping Strategies of Emergencies

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A B S T R A C T

In order to cope with the emergencies with transformation effects, we study the transformation intrinsic mechanism of emergencies and propose corresponding strategies. Firstly, we analyze the characteristics and types of emergency transformation. Secondly, we explore the causes of different types of transformation, and establish a mathematical model to analyze it. Finally, we propose coping strategies for the transformation of emergencies. The results show that the coping strategies of the one-level controllable transformation include route control strategy, multi-export dredge strategy and resistance increase strategy; the coping strategies of the multi-level controllable transformation include prediction-response strategy and control the chain reaction.

Key words: emergency, emergency transformation, transformation intrinsic mechanism, coping strategies.

Introduction

In recent years, China's emergencies have occurred frequently, which poses a serious threat to people's lives and property. Emergencies are easily transformed into various sub-emergencies, but their development and evolution process has certain rules for exploration. The research on the transformation intrinsic mechanism of emergencies helps us to explain the internal laws through external phenomena, thus providing some experience and reference for emergency managers in the practice process. Emergency managers can choose scientific and reasonable coping strategies based on this.

At present, some scholars have carried out multi-angle research on the evolution intrinsic mechanism of emergencies: Luo & Li constructed the static structure and dynamic process of mass emergencies from the perspective of system analysis, and proposed how to use the evolution intrinsic mechanism to deal with mass emergencies (Luo & Li, 2009: 163). Some scholars have used the method of system dynamics to study the evolution intrinsic mechanism of emergencies. For example, Ye, *et. al.* simulated the evolution intrinsic mechanism of the public opinion system of emergencies based on the method of system dynamics (Ye, *et. al.*, 2019: 80). Li, *et. al.* carried out a system dynamics simulation based on the data of the Tangjiashan dammed lake derived from the Wenchuan earthquake, and plotted the evolution of the emergency (Li, *et. al.*, 2015: 306). Zhao, *et. al.* constructed a situation assessment

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model for emergency response of expressway traffic emergencies based on Bayesian network, and reasoned the probability of traffic accidents under different conditions (Zhao, *et. al.*, 2018: 115). Ji, *et. al.* constructed an association rule mining model for college mass emergencies based on FP-growth algorithm (Ji, *et. al.*, 2012: 144). Sun, *et. al.*, Established a random evolutionary game model for mass emergencies in uncertain environments based on evolutionary game theory (Sun, *et. al.*, 2016: 23). These studies use relevant theories and mathematical models to reveal the laws of the evolution intrinsic mechanism of emergencies. However, there is no scholar's in-depth study of the transformation intrinsic mechanism in the above studies. Some emergencies are not very harmful, but their transformed emergencies are very harmful. For example, building fires sometimes do not threaten people's lives. However, due to people's improper escape methods, there are stampede events that threaten people's lives. Therefore, research on the transformation intrinsic mechanism of emergency can help to find some more realistic response strategies.

Characteristics and Types of Emergency Transformation

Characteristics of emergency transformation

Difference

The sub-event caused by the original event is different from the type of the original event, which is also a distinguishing feature of the transformation intrinsic mechanism from the pervasive intrinsic mechanism. For example, a flight delay at the airport and the normal order of the airport were destroyed. Because the previous aircraft occupied the runway, the subsequent delay in the aircraft is called the pervasive event. And the economic loss caused by the previous flight delay is called the transformed event.

Causality

Event A results in the occurrence of Event B, and Event B is the transformed event of Event A. There is usually a significant causal relationship between event A and event B. The event A directly or indirectly leads to the occurrence of event B, which is the loss and consequence caused by event A. For example, a building fire caused a stampede event at the door of the building.

Types of emergency transformation

According to whether the transformation of the emergency is controllable or not, the emergency transformation is divided into controllable transformation and uncontrollable transformation. Controllable transformation means that the transformation of an emergency can be controlled or partially controlled. It is known that event A has occurred, and event A may be transformed into event B, causing very serious consequences. At this point, people can artificially take measures to prevent event B from occurring or to reduce the probability of event B or reduce the damage. For example, when a building fires, people can take appropriate escape methods to avoid the occurrence of stampede event or to reduce the intensity of stampede event. Uncontrollable transformation means that the transformation of an emergency cannot be controlled or partially controlled. It is known that event A has occurred, and event A must be transformed into event B, and human factors cannot be used to intervene. For example, the loss or reduction of agricultural products must cause serious economic losses. Because all the costs of growing agricultural products have already been spent. In economics, we refer to these non-recyclable expenses as sunk costs, such as time, money, energy, and so on. When costs and income (loss or reduction) have been determined, economic losses have also been determined.

Emergency transformation can be divided into one-level transformation and multi-level transformation based on the number of levels of emergency transformation. The one-level transformation means that event A causes event B to occur, and the transformation process of the emergency ends. Event B is called one-level sub-event, and there is only one-level sub-event in the transformation process. There may also be multiple sub-events for one-level transformation. For example, event A simultaneously causes the occurrence of event B1, event B2, event B3, and so on. For example, the loss or reduction of agricultural products caused economic losses, and the economic losses were not further transformed into other events, so the transformation process was a one-level transformation. Multi-level transformation means that event A causes the occurrence of event B, event B causes the occurrence of event C, and event C causes the occurrence of event D... (call event B as a one-level sub-event, event C as a two-level sub-event, Event D as a three-level sub-event...). Multi-level transformation may also exist for multiple sub-events of the same level. For example, event A simultaneously causes the occurrence of event B_1, event B_2, event B_3, and event B simultaneously causes the occurrence of event C_1, event C_2, event C_3. For example, rainstorm disaster have transformed into urban flood disaster, and urban flood disaster have further transformed into urban traffic congestion and building collapse.

According to whether the type of the original event and the type of the sub-event are the same, the emergency transformation can be divided into similar transformation and dissimilar transformation. Emergencies are divided into four categories: natural disasters, accident disasters, public health events, and social security events. Similar transformation means that the original event and the sub-event are of the same type. For example, storms transform into mudslides are similar transformation because they are natural disasters. Dissimilar transformation means that the original event and the sub-event caused by it are of different types. For example, mass emergencies caused by accident disasters are social security events and therefore belong to dissimilar transformation.

According to whether the power of the original event and the power of the sub-event are the same or not, the emergency transformation can be divided into power consistent transformation and power inconsistent transformation. Power consistent transformation means that the power that causes the original event to occur is the same as the power that causes the sub-event to occur. For example, the transformation of heavy rain disasters into urban floods is a power consistent transformation, because the most important power for both of them is the sharp increase in rainfall in a short period of time. Power inconsistent transformation means that the power that causes the original event to occur is different from the power of the sub-event. For example, the power of a building fire is the interaction between the fire source and the combustibles. However, the driving force of the stampede is the desire of people to escape.

According to whether the original event continues after the transformation into a sub-event, the emergency transformation can be divided into inherited transformation and non-inherited transformation. Inherited transformation means that the original event ends after the sub-event occurs. For example, a fire caused by a one-time explosion. Non-inherited transformation means that after the original event is transformed into a sub-event, it will continue to occur and be transformed. For example, the earthquake will turn into a tsunami, but the earthquake will continue to expand (Zhao & He, 2019: 138).

According to whether the subject of the original event is the same as the subject of the sub-event, we divide emergency transformation into the same subject transformation and the different subject transformation. Same subject transformation means that the subject of the original event is the same as the subject of the sub-event. For example, an explosion in a building turns into a fire, and the main body is the building. Different subject transformation means that the subject of the original event is different from the subject of the sub-event. For example, building fire transform into stampede event at the door of the building. The main body of the fire disaster is the building, and the main body responsible for the stampede event is the people who are escaping.

Analysis of The Causes of Emergency Transformation

Analysis of the causes of controllable transformation and uncontrollable transformation

The conditions for controllable transformation include the following:

Disturbance of the original thing.

It means that the original thing is disturbed, deviates from the normal orbit of its operation, and produces substances, energy, and information that can be transmitted to the outside world. For example, the cause of heavy rain disasters is that there is too much rainfall, and extra rainfall will generate additional energy, which will affect the city's surface water level and urban traffic.

There is an intrinsic link between the original event and the sub-event.

Because of the inherent intrinsic link between the original event and the sub-event, the original event may be transformed into this sub-event rather than other events. For example, rainstorms can transform into urban floods rather than inflation.

The transformed thing responds to the disturbance of the original thing.

The controllable transformation can be controlled because the original event is transformed into a sub-event that requires this sub-event to make or not respond.

When the above three conditions are met at the same time, emergency caused by the disturbance of the original thing will be transformed into other event through the internal connection between things.

The conditions of uncontrollable transformation usually only include two aspects: the disturbance of the original thing and the intrinsic relationship between the original event and the sub-event. Because human behavior cannot change this transformation process, it is not the focus of our research.

Analysis of the causes of one-level and multi-level transformation

one-level transformation can be seen as a collection of one-level controllable transformation and one-level uncontrollable transformation, so we can refer to the above. The conditions for multi-level transformation include the following aspects:

Disturbance of the original thing

It means that the original thing is disturbed, deviates from the normal orbit of its operation, and produces substances, energy, and information that can be transmitted to the outside world.

There is an intrinsic connection between the original thing and the transformed thing.

It means that there is an intrinsic inevitable connection between event A and event B, and there is an inherent inevitable connection between event B and event C... which causes event A to be transformed into event B and event B to be transformed into event C. It is not the intrinsic inevitable connection between event A and event C.

When both of the above conditions are met, emergency caused by the disturbance of the original thing will be transformed to other events after multi-level transformation.

Modeling Analysis of Emergency Transformation

In order to better characterize the transformation intrinsic mechanism of emergencies, modeling and analysis of emergency transformation. By establishing a model, we can derive the conditions for the occurrence of emergency transformation and the conditions for slowing down or suspending the transformation of emergencies, and provide theoretical support for formulating corresponding solutions when the emergency transformation occurs.

Assume that the number of things affected by the emergency transformation is n, and the things affected are A_1, A_2, ..., A_n, and the degree of influence caused by the single thing A_i is E_i, the total degree of influence of the transformation is S, then:

$$S=\sum_{i=1}^{n} E_i$$

If i=1, it means that the emergency transformation is a one-level transformation, and the transformation only produces a single one-level sub-event. For example, a building fire is transformed into a stampede event at building exits, and no other transformation events have occurred. If i>1, it means that the emergency transformation is a one-level transformation, but the transformation produces two or more one-level sub-events. Or the emergency transformation is a multi-level transformation and produces two or more multi-level sub-events. The following will model and analyze the first-level controllable transformation and multi-level controllable transformation:

Modeling analysis of one-level controllable transformation

The transformation effect produced by event A into event B can be represented by "energy". Suppose that the energy E_i of the thing A_i has a ratio of α_i which can be transformed into B_i, and the transformed energy needs to reach F_i to cause B_i to occur. The resistance level of B_i itself is R_i. When the B_i event occurs, the energy of B_i itself is Q_i, and the ratio that can be aroused is β_i, then:

$$E=\begin{cases}0 & \alpha_i E_i < F_i \\ \alpha_i E_i+\beta_i Q_i-R_i & \alpha_i E_i \geq F_i\end{cases}$$

For the whole process of event A transforms into event B, whether event B occurs and the extent of occurrence depends on the energy and transformation ratio of event A, the energy of event B itself meanwhile the proportion of energy being aroused and the resistance level of event B itself.

(1) The critical point energy F_i of the event B_i. When event A transforms its own energy into event B, event B will only occur when it reaches a certain degree and proportion, and this energy is called the critical point energy of event B. F_i is closely related to the nature of the event B subject itself.

(2) The energy E_i produced by event A_i and the ratio α_i that can be transformed. In the process of emergency transformation, the energy generated by event A_i is the necessary condition and source to promote the subsequent events. However, during the energy transformation of event A_i, energy may be lost, so some energy may not be transformed into subsequent events. At this point, the energy that can be transformed into the latter event is less than all of the energy of the event A_i. When the energy transformed into the subsequent event $\alpha_i E_i < F_i$, the emergency A_i will not transform

into the event B_i. In the process of transformation, the loss of energy may have the following reasons: First, the dispersion of energy during the transformation process. In the process of transformation, the energy of event A_i may be transformed into other things besides being transformed into event B_i. For example, when a rainstorm occurs, part of the rainwater accumulates in the city, and part of the rainwater infiltrates along the urban ground. Second, there is resistance in the transformation process. When there is resistance during the transformation, the energy of the event A_i is weakened. Third, the reason for transforming media properties. Event A_i may be in an environment that is not suitable for transmitting energy. The channel of event A_i is blocked and may hinder transformation.

(3) The energy Q_i of the event B_i itself and the ratio aroused is β_i. The energy of the transformed thing itself determines the maximum energy that can be aroused. For example, in the event of a fire in a building, it may turn into stampede event at the entrance of the building. The total number of people in the building determines the maximum energy of the stampede event. The proportion that is motivated depends on the means of escape. If the means of escape are correct, there may be no or a slight crowded. If the means and methods of escape are not correct, a more serious stampede may occur.

(4) The resistance level of event B itself R_i. Event B_i may generate thrust or resistance to promote or hinder the occurrence of event B_i when encountering an emergency, so R_i may be positive or negative. For example, when a building is in a fire, people in the building will try to avoid stampede event when they escape, and people's correct escape knowledge and behavior will form the resistance of event B_i. At this time, R_i is a positive number; If R_i accelerates the transformation event, R_i is negative.

Modeling analysis of multi-level controllable transformation

It is assumed that the ratio of the energy E_i with α_i of the event A_i can be transformed to B_i, and the energy of the transformation needs to reach F_{1i} to cause the occurrence of B_i. The resistance of B_i itself is R_{1i}. When the B_i event occurs, the energy of B_i itself is Q_{1i}, Among them, the proportion of β_{1i} can be aroused. The ratio of energy Q_{1i} with β_{1i} of event B_i can be transformed into C_i, and the energy of transformation needs to reach F_{2i} to lead to the occurrence of C_i. The resistance of C_i itself is R_{2i}. When the C_i event occurs, the energy of C_i itself is Q_{2i}, which can be aroused. The ratio is β_{2i}.... Then there are:

$$E=\begin{cases}0 & \alpha_i E_i < F_{1i} \\ \alpha_i E_i+\beta_{1i}Q_{1i}-R_{1i} & \alpha_i E_i \geq F_{1i} \\ \alpha_i E_i+(\beta_{1i}Q_{1i}+\beta_{2i}Q_{2i}+...,\beta_{ni}Q_{ni})-(R_{1i}+R_{2i}+...R_{ni}) & \\ \alpha_i E_i \geq F_{1i},\beta_{1i}Q_{1i} \geq F_{2i},...\beta_{(n-1)i}Q_{(n-1)i} \geq F_{ni} & \end{cases}$$

As mentioned before, for the whole process of event A transform into event B, whether or not event B occurs and the extent of occurrence depends on the energy of event A and the proportion of transformation, the energy and the proportion of being aroused of event B, and the degree of resistance of event B. Therefore, for multi-level controllable transformation events, each level of transformation is critical. Since the latter level event is transformed from the previous level event. The earlier the control, the less the level, thereby helping to mitigate the loss caused by the transformation.

Coping Strategies of Emergencies Transformation

Coping strategies for one-level controllable transformation

(1) Route control strategy. In the process of an emergency event happens, different external environments will promote or hinder the development of the event, and there is a choice of the path. If the development path of the emergency is effectively controlled, the transformation of the emergency can be actively intervened to a large extent (Qi Jingjing, & Chen An, 2009:496).

(2) Multi-export dredge strategy. In order to make the energy generated by the original emergency event not all passed to the sub-event, the energy generated by the original emergency event can be divided into multiple exits. Release and mitigate the severity of sub-events. For example, in order to avoid people's difficulties in escape after a fire in a building, it is possible to increase the exit when designing and constructing a building. In the event of a fire, people can escape from multiple exits, thereby avoiding the occurrence of stampede events or reducing their intensity.

(3) Resistance increase strategy. When the original emergency occurs, if it can be determined that it will be transformed into the corresponding sub-event under certain conditions,

then the resistance can be increased, and the conditions can not be satisfied, thus avoiding the occurrence of sub-events. For example, if a major public crisis event is known to the public, it will inevitably lead to serious mass emergencies or network public opinion emergencies. The relevant information can be temporarily blocked. After the crisis is lifted, it can be publicized to avoid confusion of social order.

Coping strategies for multi-level controllable transformation

(1) prediction - response strategy. Before the multi-level controllable transformation occurs, it is necessary to make a reasonable prediction of the possible transformation events, and make corresponding measures. For example, in the event of a rainstorm, we can predict that it may affect the city's water level, the probability of urban flooding increases, and urban flooding will have an impact on urban traffic... The basis for the prediction can be either the previous experience or the judgment based on the intrinsic link between the events. After the predict, reasonable and effective measures should be taken to avoid the occurrence of multi-level transformation events.

(2) Control the chain reaction. In the case of multi-level controllable transformation, the transformation event can be effectively controlled at the high level to avoid the transformation event from continuing to the next level of emergency. For example, when a rainstorm disaster occurs, measures should be taken to prevent it from being transformed into a city flood disaster, so the urban traffic congestion emergency is avoided as much as possible.

Conclusion

Modeling and analyzing the intrinsic mechanism of emergency events transformation helps people to take appropriate measures to deal with emergencies, to avoid the occurrence of transformation events or to reduce the intensity of their occurrence, thus protecting people's lives and property. At the same time, in response to a transformation event, the appropriate strategy should be selected according to the characteristics, type, cause, severity, and development trend of the transformation event. In the future research work, the author will further study the transformation intrinsic mechanism of emergencies, especially the quantitative relationship between the response measures and the consequences of the transformation events to further explore the practice.

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