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The utility of a panic model on simulating crowd disasters

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Outline



- Definitions of panic
- A panic growth model
- Review of campus stampedes in China
- Meanings to egress simulation and crowd control



Stampede in Cambodia



Theater fire and panic



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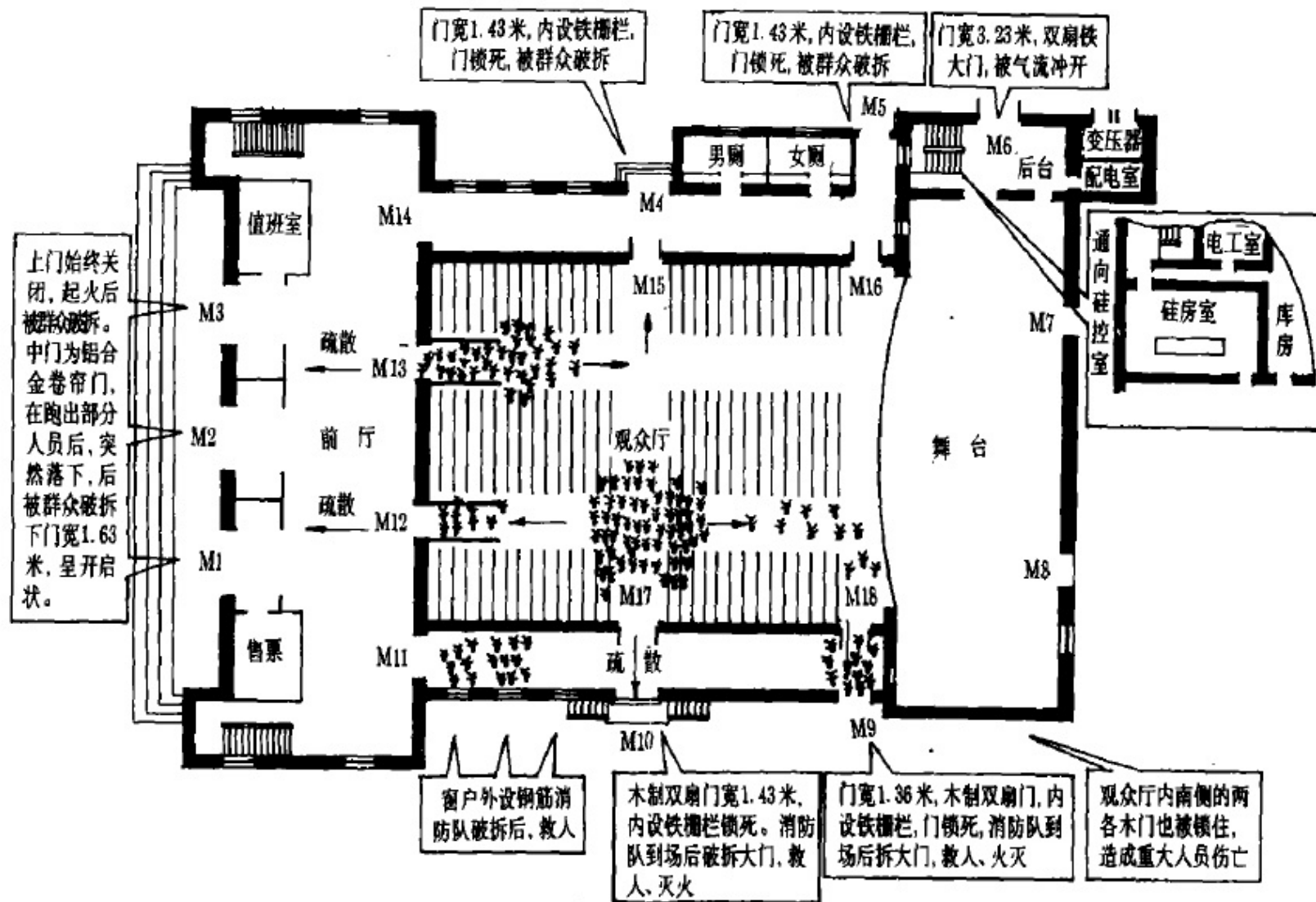


图1
“12.8”特大火灾遇难人员分布位置、破拆门窗平面示意

注: 火灾时, 所有外门均锁闭状, 仅1号门呈开启状。内门17号和18号被锁闭, 其余呈开启状。



Definitions of Panic (1/2)



- Panic is the crowd in dissolution. (Park et al., 1924)
- Panic behavior is the antithesis of regimental behavior, uncoordinated interaction with unpredictable consequences. (LaPierre, 1938)
- Panic is a type of rout, an ephemeral form of collective behavior.
- (Foreman, 1953)
- Panic is an acute fear reaction marked by loss of self-control, followed by “non-social and non-rational flight”. (Quarantelli, E.L. (1954)
- Panic is a collective retreat from group goals into a state of extreme ‘privatization’. (Lang, et al., 1961)
- Panic is a collective flight based on a hysterical belief, a belief that a definite threat is present and that escape routes are closing. (Goldenson, 1984)
- Panic is a reaction involving terror, confusion and irrational behavior, precipitated by a threatening situation. (Goldenson, 1984)
- The word panic is often applied to a strictly individual, maladaptive reaction of flight, immobility, or disorganization stemming from intense fear. Individual panic frequently occurs as a unique individual response without triggering a similar reaction to others. Panic as collective behavior, however, is shared behavior. (Nolan, 2006)



Definitions of Panic (2/2)



- General public believe that irrational flight is at the heart of panic behavior. Many theorists have characterized panic as terror stricken, irrational, flight behavior where the rule is “every man for himself”. In sociology, precipitate and irrational actions of a group are often referenced to as panics. (Russell, 2008)
- A sudden, overpowering terror, often affecting many people at once. (The free dictionary, online)
- A sudden overpowering fright; acute extreme anxiety (Merriam Webster Online dictionary)
- A sudden strong feeling of fear that prevents reasonable thought or action. (Medical Online dictionary)
- The word panic is often applied to a strictly individual, maladaptive reaction of flight, immobility, or disorganization stemming from intense fear. (Encyclopedia Britannica, 2008)
- Panic is a sudden fear which dominates or replaces thinking and often affects groups of people or animals. (Wikipedia, 2011)
- Panic is a sudden overpowering fright, especially a sudden terror often inspired by a trifling cause or a misapprehension of danger and accompanied by unreasoning or frantic efforts to secure safety. (Oxford dictionary)



Results of panic



- Panic is **disorganization due to fear**, similar to the crowd in dissolution.
- Panic leads to injudicious decision making under emergency.
- Stampede/Crushing/Drowning/Poisoning/Jumping





Classification of Panic



- Escape panic
- Acquisitive panic
- Aggressive panic
- *Negative panic*



Acquisitive



Escape

Aggressive



Symptoms of panic (1/3)



- (1) People move or try to move considerably faster than normal.
- (2) Individuals start pushing, and interactions among people become physical in nature.
- (3) Moving and, in particular, passing of a bottleneck becomes uncoordinated.





Symptoms of panic (2/3)



- (4) At exits, arching and clogging are observed.
- (5) Jams build up.
- (6) The physical interactions in the jammed crowd add up and cause dangerous pressures up to $4,450 \text{ N m}^{-1}$ which can bend steel barriers or push down brick walls.

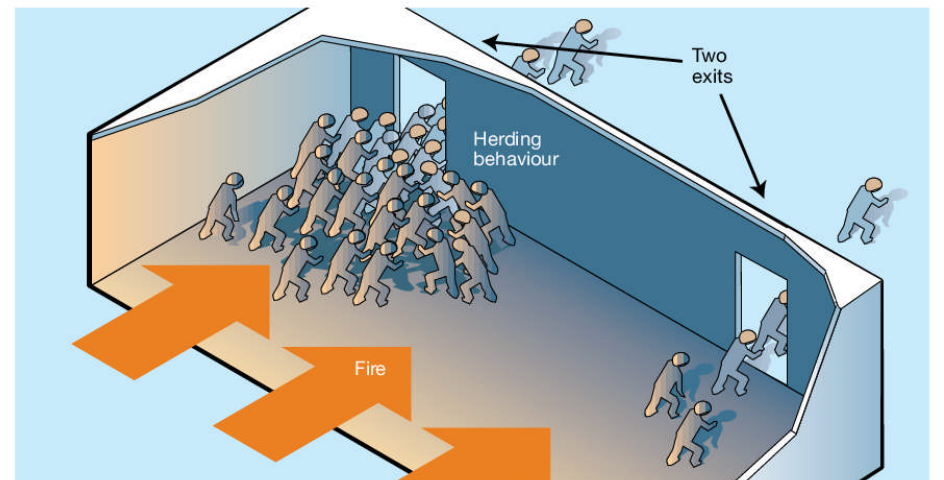




Symptoms of panic (3/3)

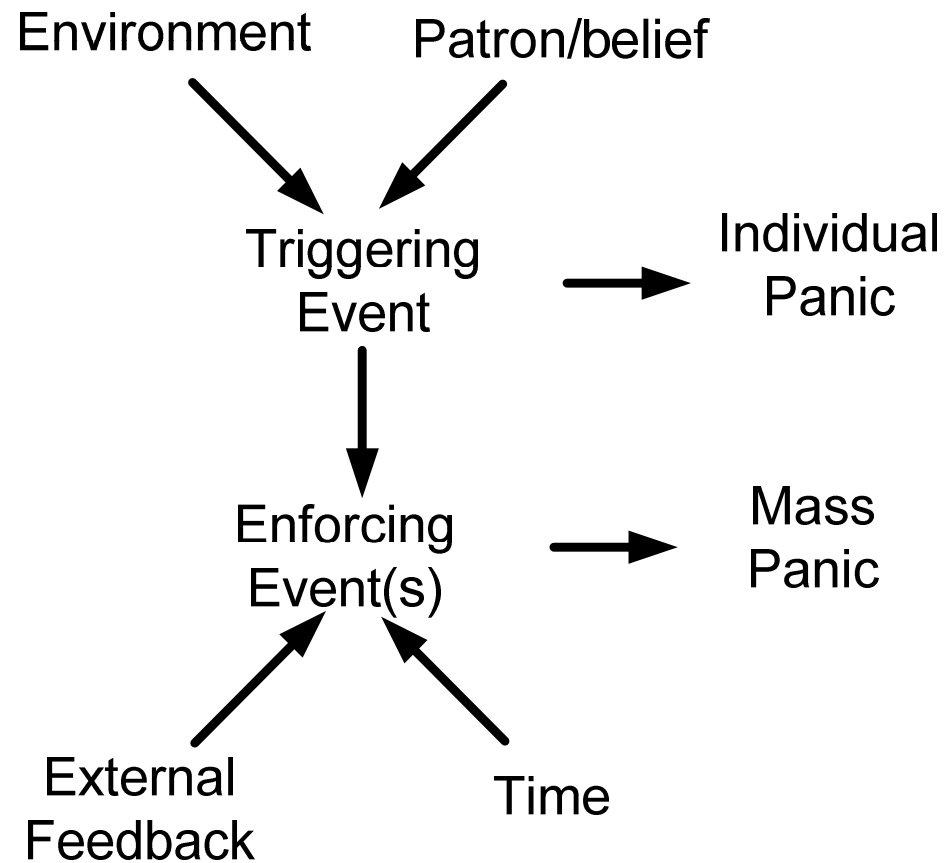


- (7) Escape is further slowed by fallen or injured people acting as 'obstacles'.
- (8) People show a tendency towards mass behavior, that is, to do what other people do.
- (9) Alternative exits are often overlooked or not efficiently used in escape situations





Panic model





From individual to mass panic

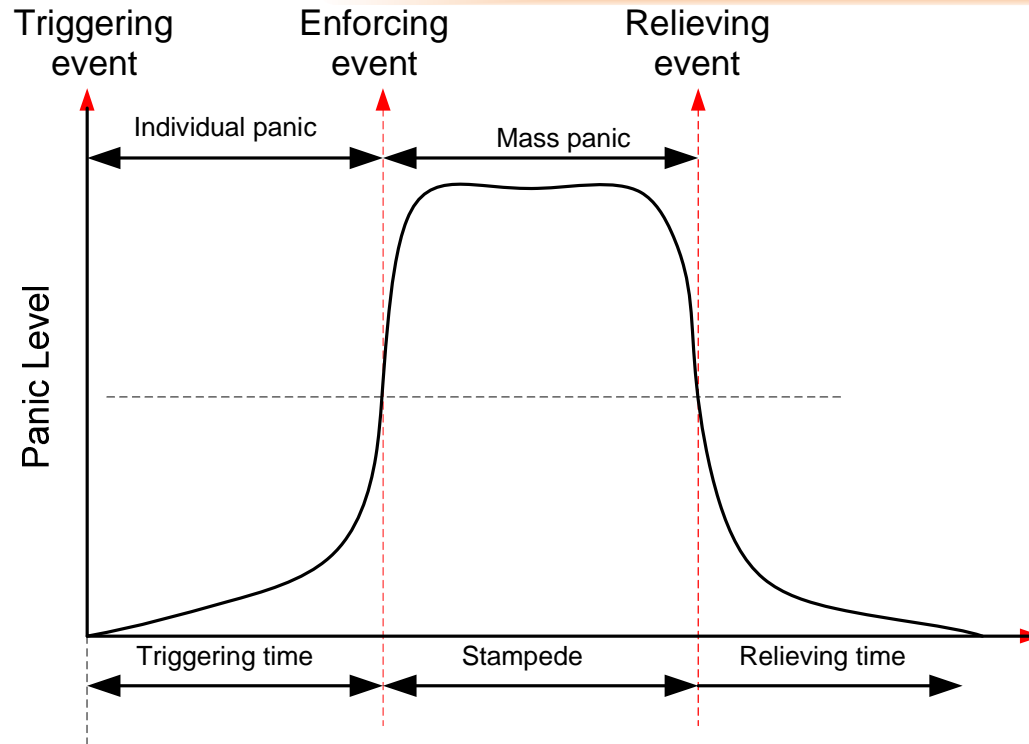


- Individual Panic vs. Mass(collective) panic

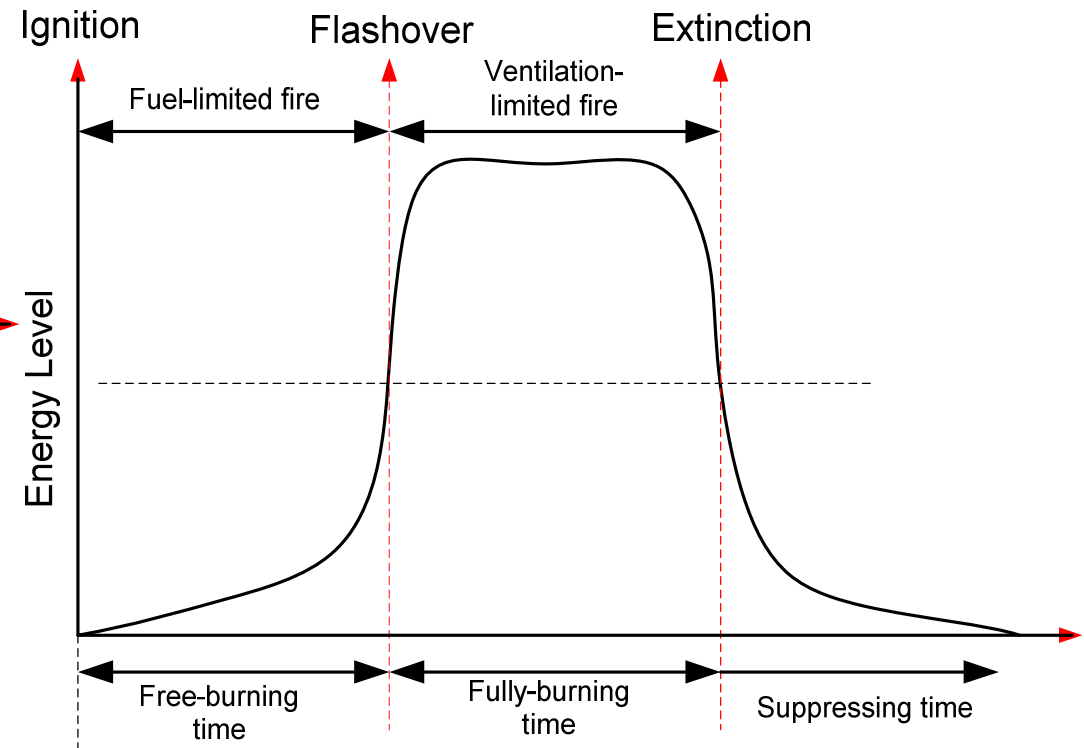




A panic curve



Panic growth in a crowd



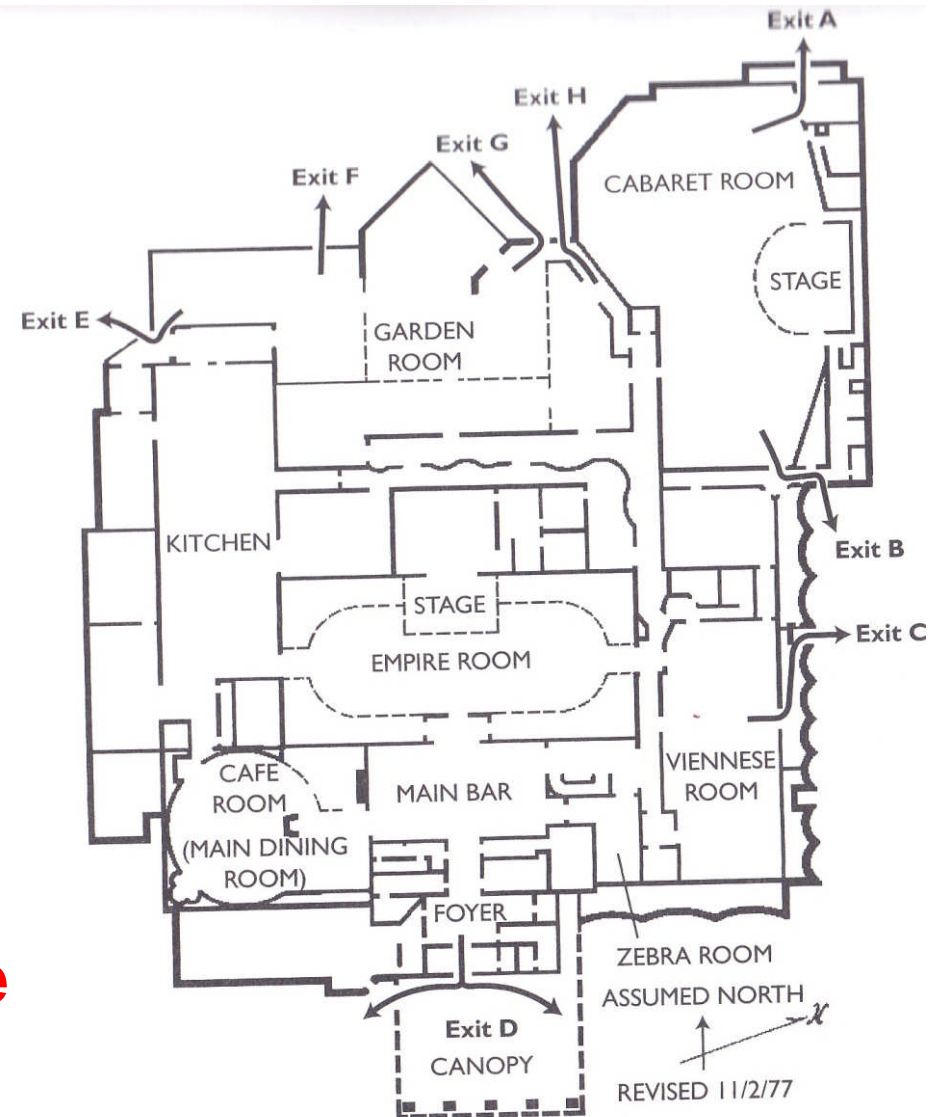
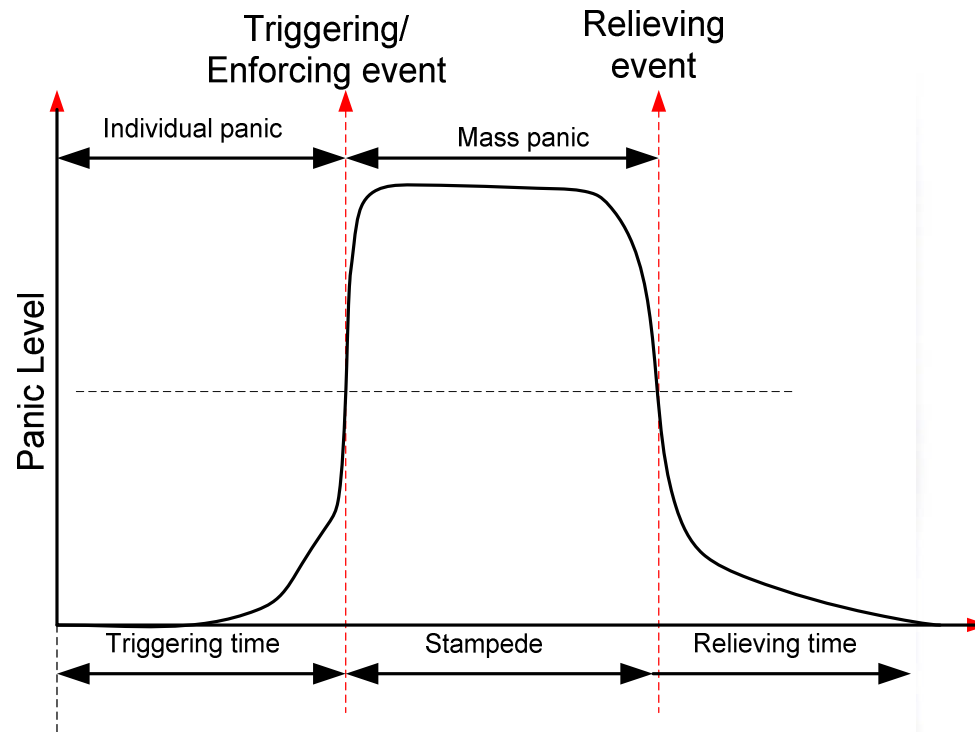
Fire growth in a compartment 13



Variations of panic growth curve



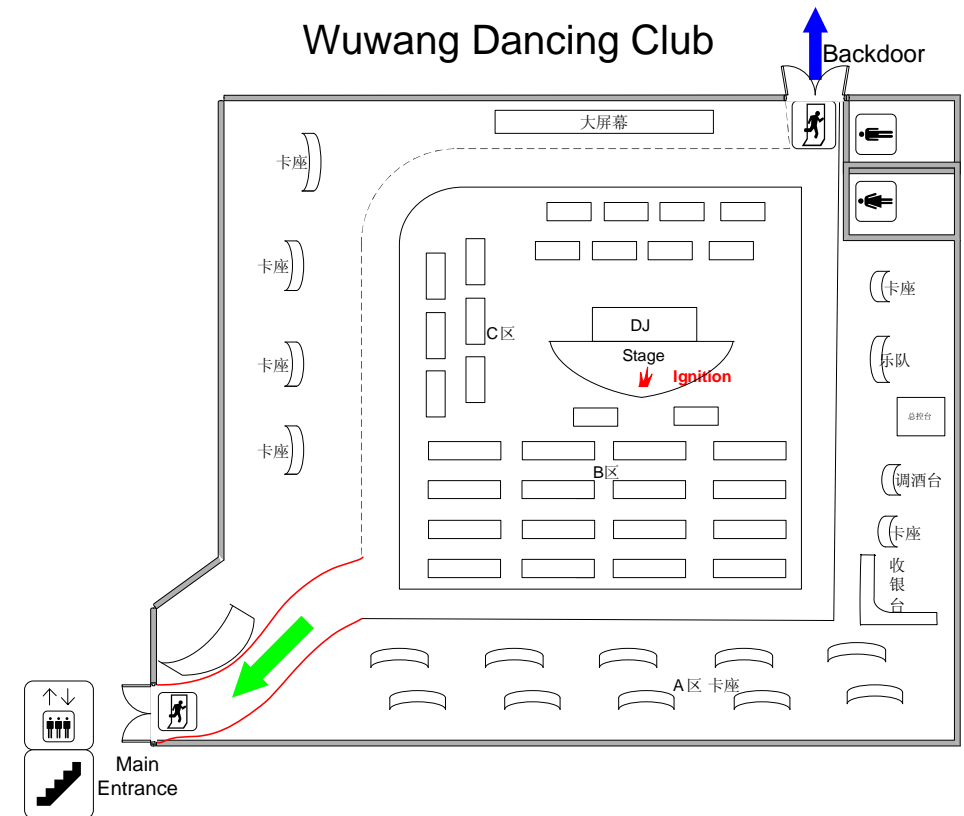
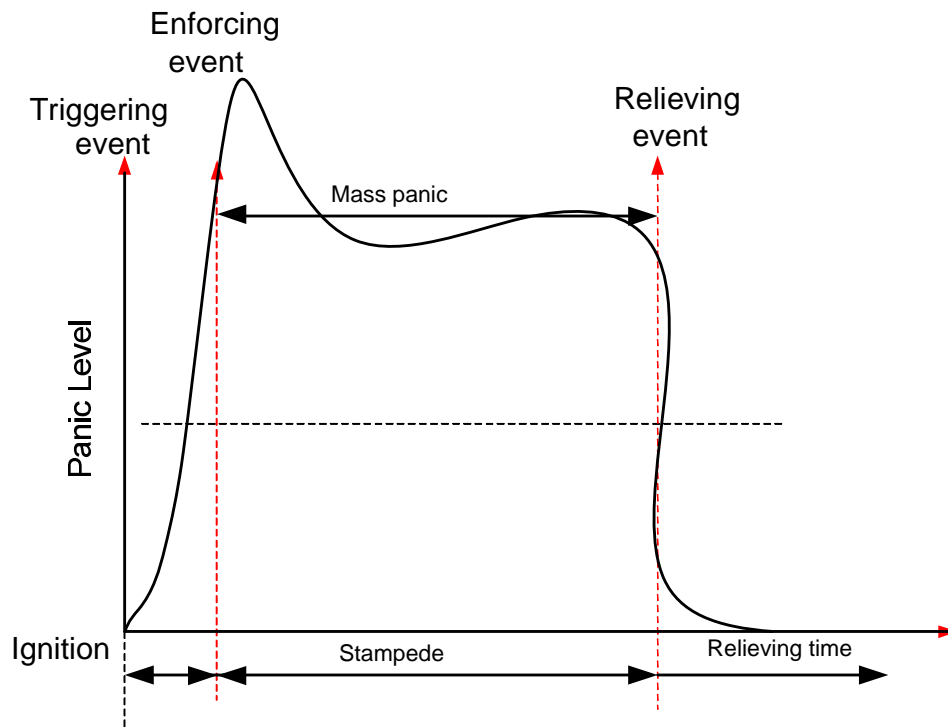
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Beverleyhills Supper Club fire



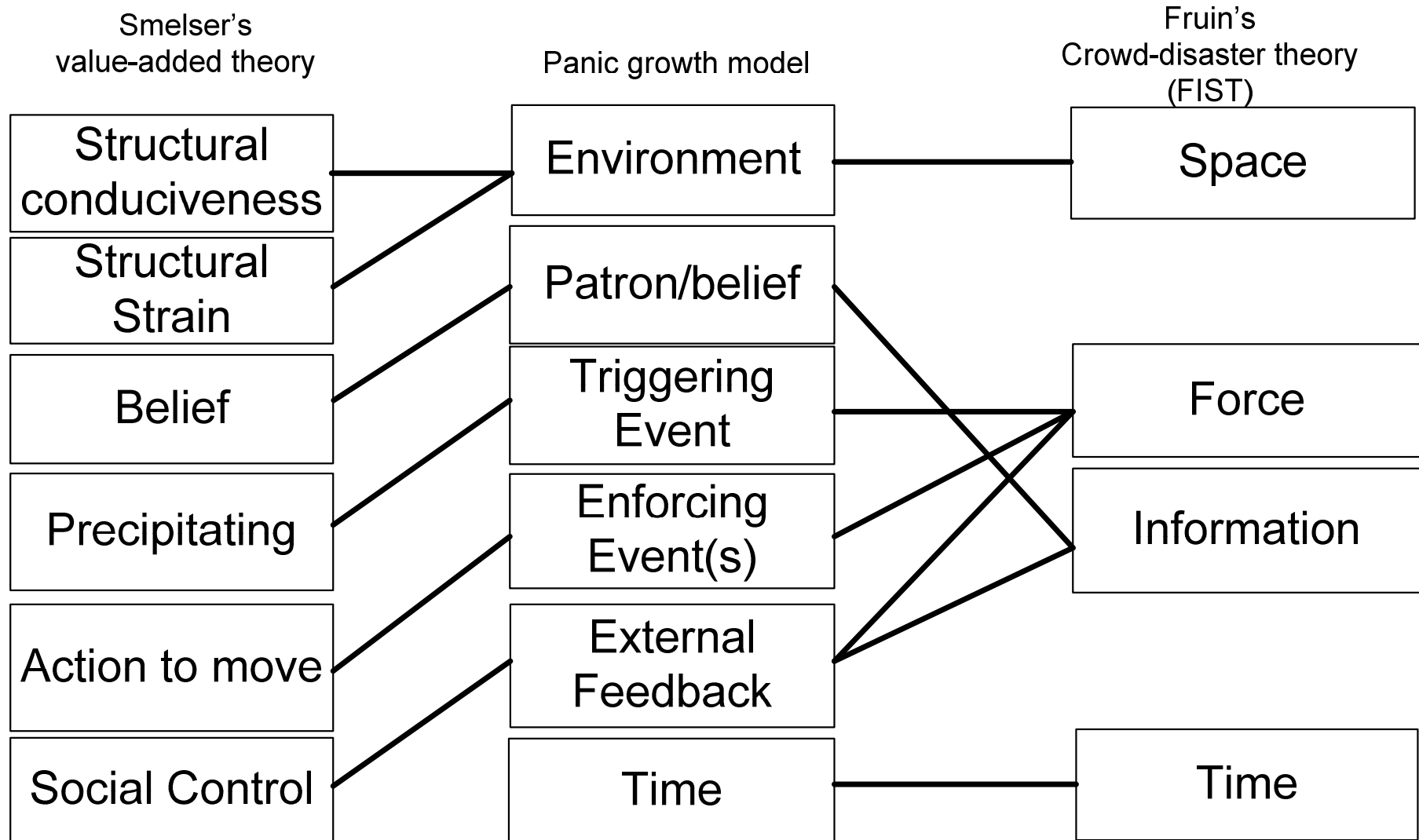
Variations of panic growth curve



Wuwang Dancing Club fire



Comparison with other models





Campus stampedes in China



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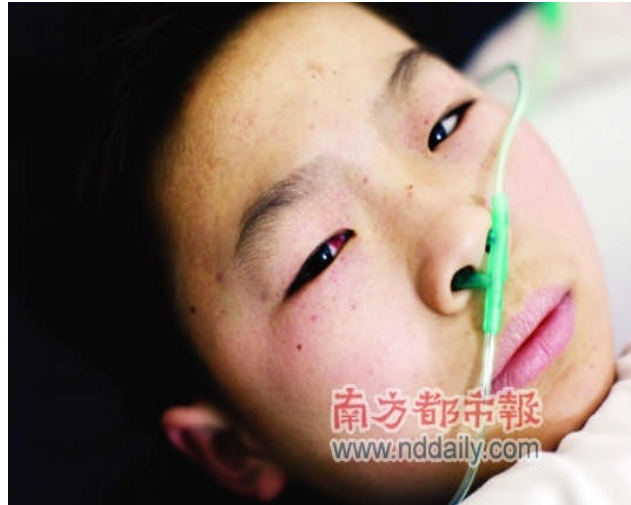




Victims of Stampede



Sichuan



Hunan



Hunan, Loudi



Sichuan, Earthquake



Xinjiang



Jiangxi, Earthquake



Environmental factor





Victim profiles

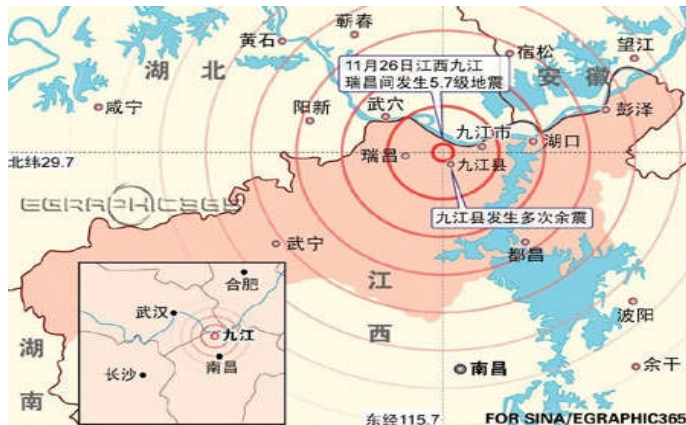




Causes of Stampede

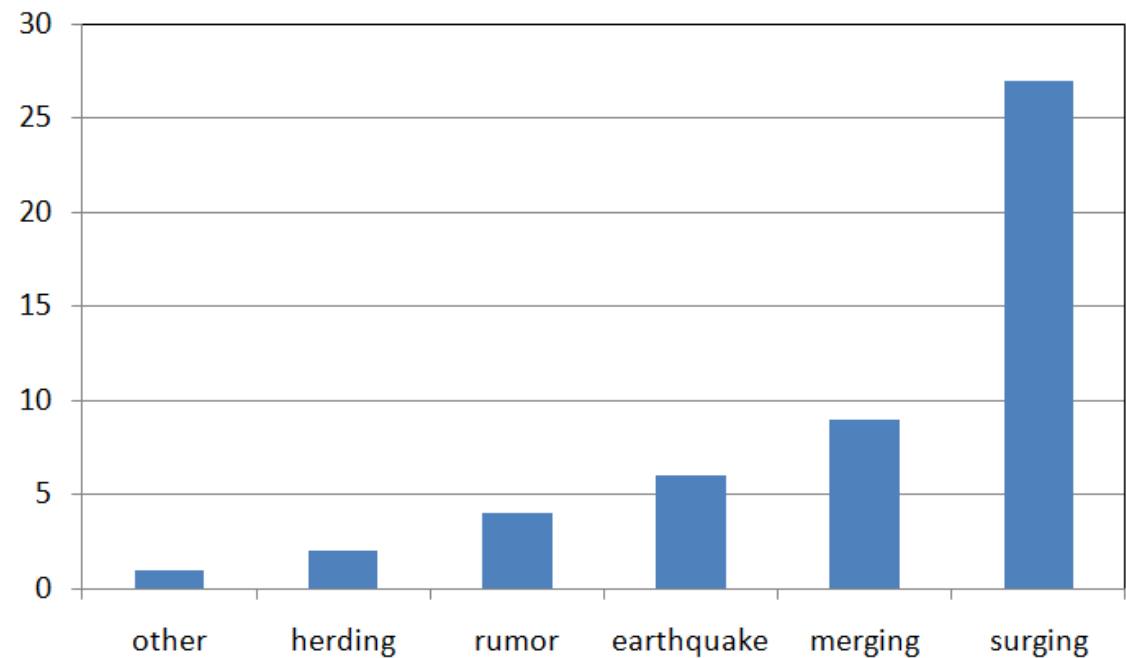
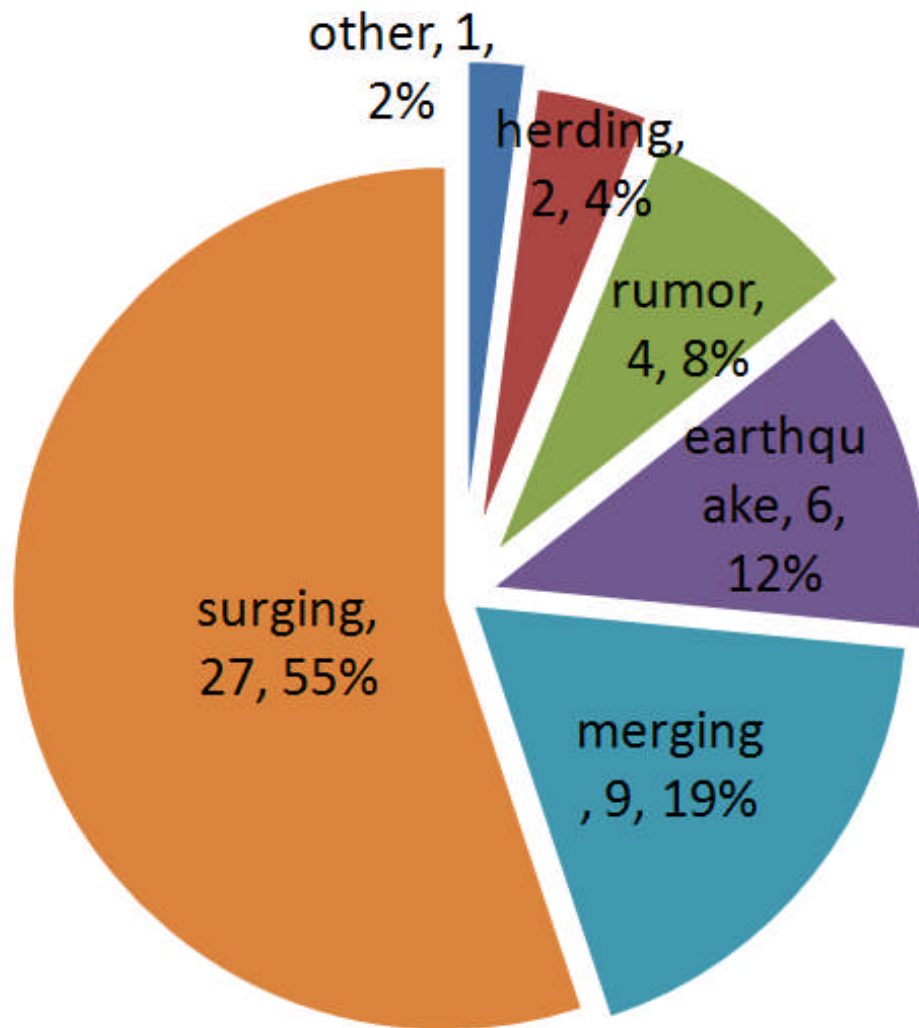


- Triggering events
 - Merging
 - Surging
 - Herding
 - Earthquake
 - Rumor





Triggering events

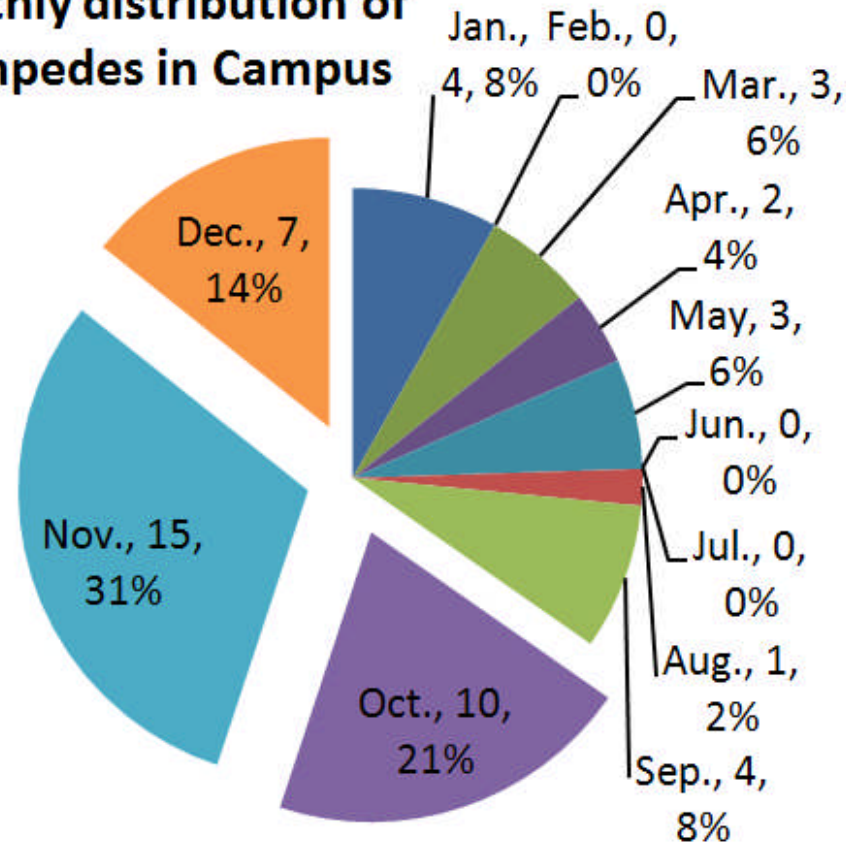




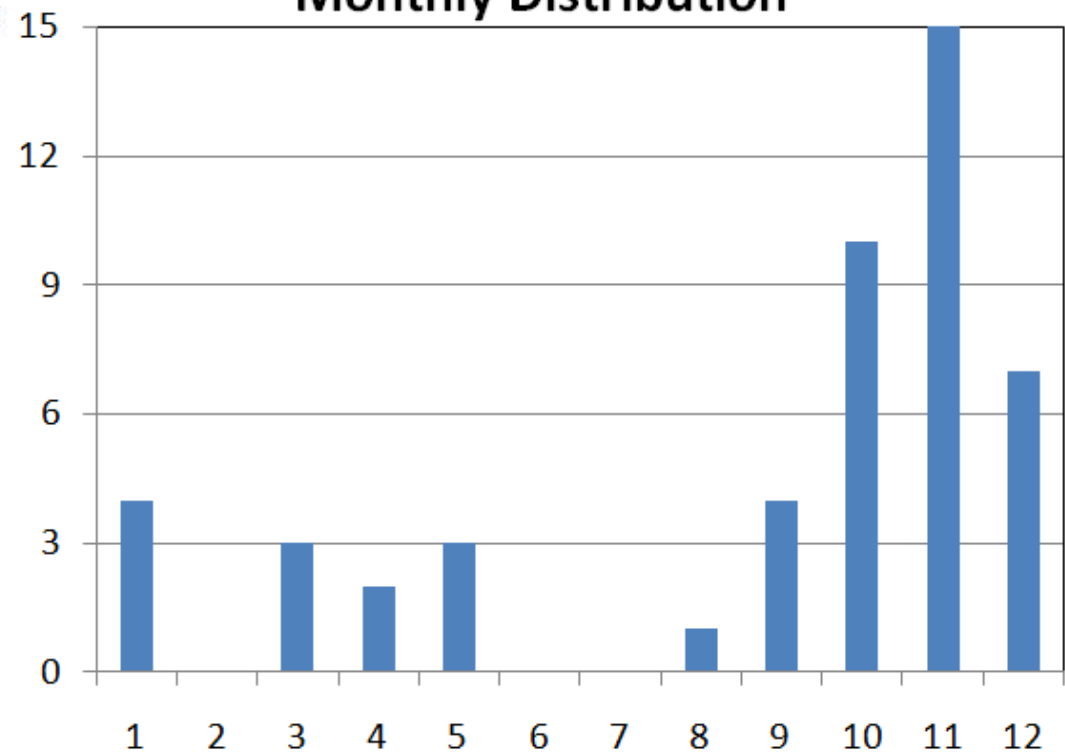
Temporal distribution of Stampede in Campus



Monthly distribution of Stampedes in Campus



Monthly Distribution

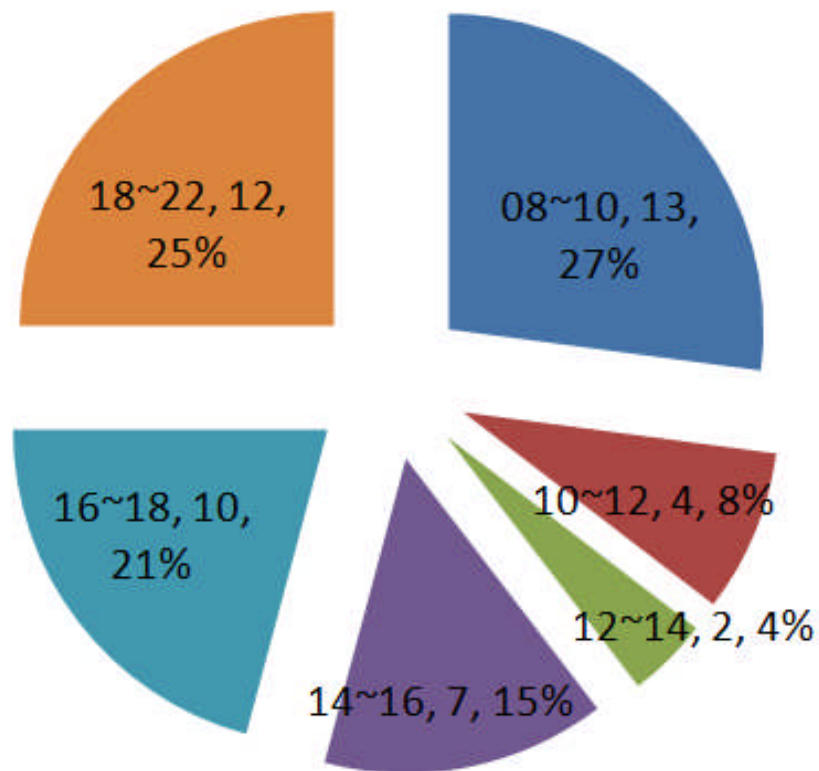




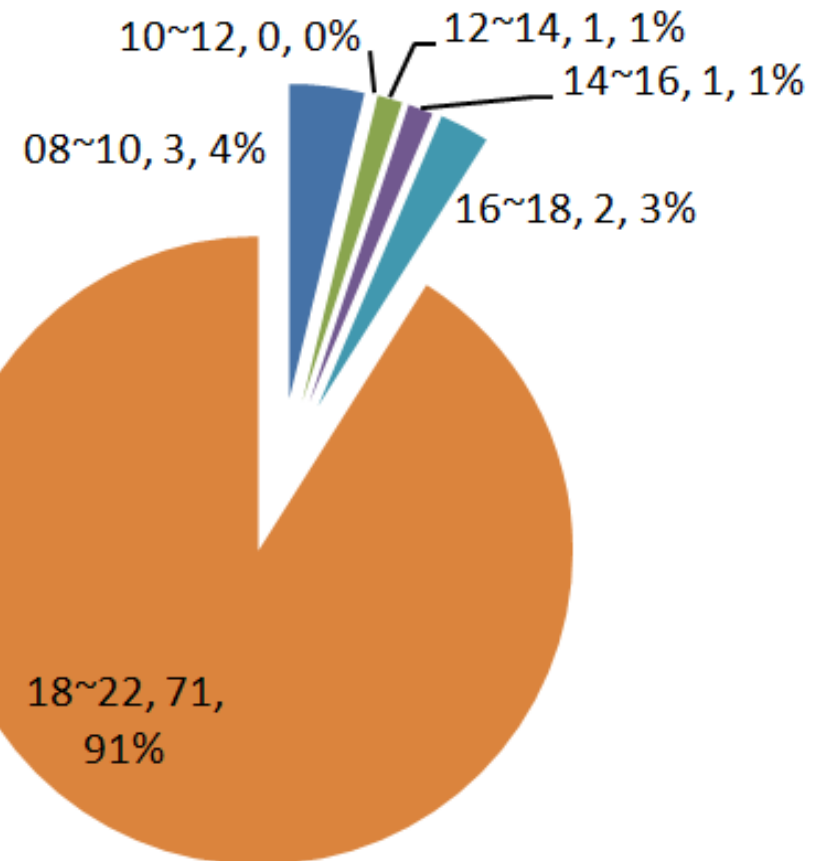
Time factors



Incidents occurring time

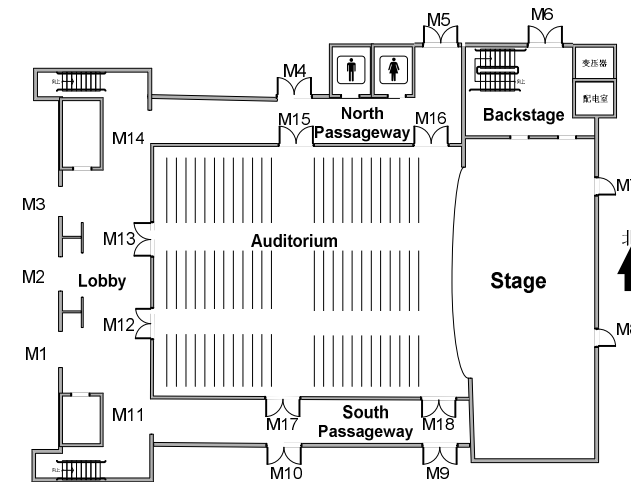


Fatalities occurring time





What contributes to the panic in Karamay theater fire?



- Partial loss of exits/loss of power
- Unsuitable children/teachers ratio 709/45~16
- Fire-related explosion and backdraft phenomena
- Continuous rapid flame spread
- Missing of external control
- More than 10 minutes of stampede in 4 locations



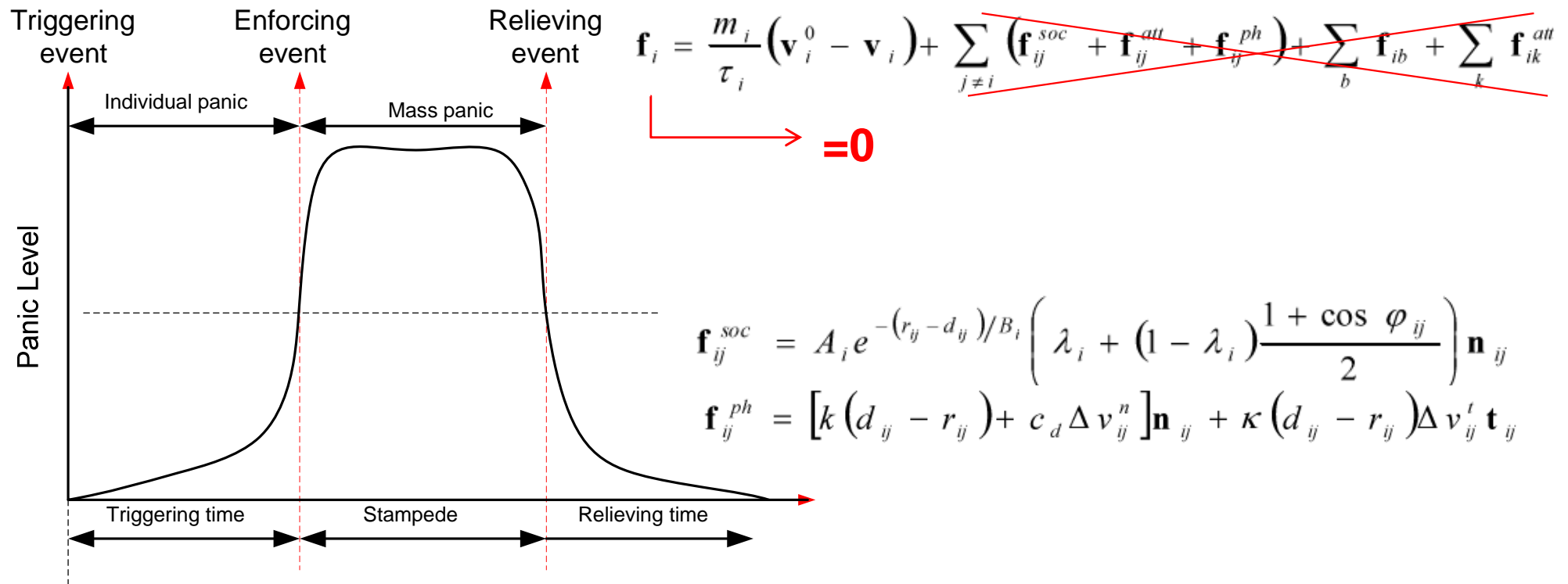
How to use panic in crowd simulation?



- Real-time diagnosis of panic (disorganization) level
- Trigger the panic algorithm (currently used in FDS-EVAC)
- When to release the external help?
- How to estimate the life losses in a stampede?



How to simulate panic?



- People show a tendency towards mass behavior, that is, to do what other people do.



Real-time diagnosis (Measurement) of Panic



Forces



Noises



Disorganization





Why panic is rare?



- Panic can only be deduced from results (Sime, 1980), while most researchers tried to observe panic in a disaster (Drury, 2005).
- Panic has both physical outlook and emotional contributions.
- Panic is a cultural and linguistic concept.
- Panic is a growing concept.
- Rationality is a relative concept in social science.
- Panic is a spontaneous response, while learned responses improve over time.
- Panic works only when the environment is insufficient or the population is unprepared.



A philosophy



治乱，数也；
勇怯，势也；
强弱，形也。

- Order and disorder are a matter of organization, courage and cowardice are a matter of momentum, strong and weak are a matter of display.
 - From *The art of War by Sun Tzu*.



Summary



- Based on a review of definitions, panic is disorganization due to fear.
- A panic growth model is proposed to explain the outcome of crowd disasters.
- Campus stampedes in China support the current panic algorithm in FDS-EVAC.
- Simulation of a crowd disaster depends on the monitoring of panic level in a crowd.