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Review Article

# Framework for stampede management: Preventable mass disaster

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## Abstract

Anywhere in the world that people congregate in large numbers, including mass gathering events, there is a significant risk of human stampedes. This research examines stampede data from political, religious, and entertainment events in India to create a useful paradigm for reducing risks associated with large-scale assemblies. In India, almost 80% of stampedes have taken place at religious gatherings or during pilgrimages. Significant incidents and fatalities have been recorded from a number of states, and there have been repeated stampedes in specific areas. The massive crowds and the ever-expanding site have made risk management techniques extremely inefficient and ineffective.

Studies have gradually superseded the conventional wisdom that mass disasters in form of stampede are the product of a panicked and irrational populations, indicating that a series of structural failures are the primary underlying reasons. Based on case studies, it has been shown what causes human stampedes and that a simple mishap, a deliberate act, or simply a rumour can set off a disruption in the crowd. Venue deficiencies, such as a remote or dangerous location, substandard amenities, or a dearth of basic infrastructure and medical services, could make these meetings more vulnerable.

A basic framework aligned on interconnected compartments for inter-agency cooperation and multidisciplinary contemplation, ranging from hazard identification to the execution of mitigation measures for human stampede risk reduction, has been developed as a result of the risk factors identified from the analysis of previous incidents. Decisions being made slowly, inadequate triage, or losing medical records are frequent response issues that could make the situation worse.

**Keywords:** Mass gathering, Procession, Crowding, Accidents, Trauma management.

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## 1. Introduction

The trend of individuals congregating for a shared interest and India's growing population[1] contribute to the growing crowding during events, particularly religious ones. While both spectators and participants can be found in a crowd, participants make up the majority of the crowd in religious assemblies (the devotees). There are certain exceptions to this rule. "More than a specified number of persons at a specific location for a specific purpose for a defined period of time" is how the WHO defines mass gatherings.[2] This definition brings in the aspect of time. Emergency medicine frequently describes a mass gathering as a planned event in designated temporary facilities or an open area with a gathering of participants and spectators, during which time the community, state, or country's emergency response may be delayed due to restricted access or other issues.[3-8]

During a recent mass gathering in India, there were around 2,50,000 attendees in a small town of Hathras, Uttar Pradesh whereas the permission was granted only for 80,000 individuals. This number of devotees/attendees form around 17% of total population rise in a single day for the district, for whom the administration deployed only 80 police personals.[9] A portion of the public finds large crowds annoying and problematic, which can cause major traffic jams, a surge in crime, pollution, diseases, chaotic activities in the area, and other issues,[10] all of which can lead to medical problems and natural disasters.

Stampede frequently causes crowds to move more erratically and dangerously in an attempt to defend

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themselves, which can result in fatalities and serious injuries.[11] The main cause of death in stampedes is crushing and asphyxia from the intense pressure (up to 4500 N/m) exerted on the chest by the crowd's push.[12]

There is, however, a dearth of research accessible from this perspective since mass gathering dangers have not been prioritised for study within the context of disaster risk management to conceptualise effective planning, readiness, and response. Helbing and Molnar[13] introduced the social force model, which can simulate crowd movement and show the movement of the terrified crowd during the evacuation process, in order to depict the conduct of pedestrian flow. It is now commonly acknowledged that crowd behaviour is a social and dynamic phenomena that is independent of circumstance and that it is in turn impacted and generated by its smallest unit, namely individual.[14]

## 2. Literary Depictions of Human Stampedes

Soomaroo and Murray[15] conducted a search of peer-reviewed articles and literature to identify incidents of mass gathering disasters that occurred between 1971 and 2011. Developing nations have an eight-fold greater death rate from stampedes during large-scale gatherings than the rest of the world.[16]

The three most deadly stampedes in human history during the last century occurred in Mina Valley during the yearly Hajj in 2006 resulting in 380 fatalities,[17] during a religious procession in Baghdad in 2005 (965 fatalities), and in Phnom Penh during the Black Friday shopping stampede in 2010 (resulting in 347 fatalities) in Cambodia.[19] The epidemiology of stampedes at the religious gathering of Sabarimala, in state of Kerala, where devotees from all over India—more than the state's total population—congregate in a matter of weeks, has also been studied by Pradeep Kumar et al.[20]

## 3. Materials and Methods

In order to develop a disaster risk reduction framework for mass gathering events, the goal of this study is to comprehend mass gatherings and the ensuing human stampedes that occur in India. The news media, internet reports, and peer-reviewed literature were searched for mass gathering events. The resulting information was then used to create a chronology of the incidents, including the date, time, location, kind of event, location triggering factor, approximate crowd size, casualties, and injuries. In order to provide a framework for reducing the risk of human stampedes during large gathering events, a thorough examination of crowd disasters was conducted using both individual case studies and the collective data.

### *3.1. India's mass gathering profile*

India is referred to as the nation of festivals and is a melting pot of many cultures and religions.[21] Given that it is home to the greatest diversity of religions, most towns hold religious gatherings that draw sizable crowds of people to public or private areas. The administration and organising agencies face significant obstacles due to the unavoidable overcrowding at these types of events, which increases the possibility of stampedes.

Efficient contingency planning is necessary to ensure a secure and healthy mass gathering. Knowledge of the fundamental characteristics of gatherings is crucial for developing efficient preparation measures, which will differ based on the type of incident.

These are large-scale events that are planned for both separate and same venues. Religious assemblies such as the Kumbh Mela, the largest mass gathering event in India, take place alternately four times every twelve years in Allahabad, Nasik, Ujjain, and Hardwar.[22] Similar to this, there are several other activities (sports, concerts, processions, etc.) that are planned both at the same venue and at separate locations, as well as numerous religious meetings.The four main categories are religious crowds, entertainment events, political gatherings, and spontaneously formed (miscellaneous) gatherings.

## 4. Results and Discussion

### *4.1. Human stampedes: An analysis based on events*

The Indian government's record of crimes and unnatural deaths is kept updated by the National Crime Records Bureau (NCRB), Ministry of Home Affairs. The total number of stampede deaths since 1996 is compiled in the NCRB report on "Accidental deaths and Suicides in India." According to data obtained from NCRB records for the years 2000–2015, there have been 2823 fatalities in India as a result of human stampedes. The annual fatalities from 2001 to 2015 are displayed in **Figure 1**.

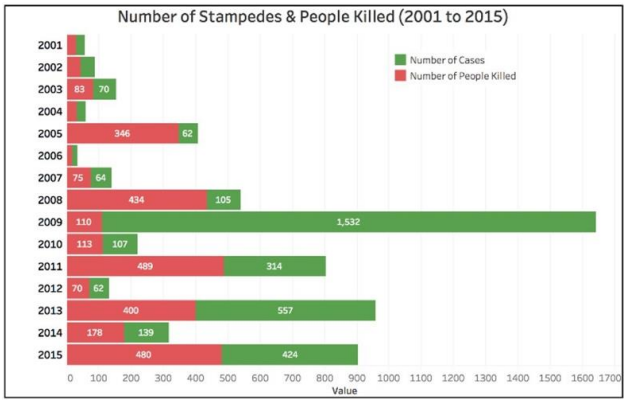


**Figure 1:** Bar diagram showing annual fatalites from 2001-2015

The latest addition to this list is the stampede at Hathras town (Uttar Pradesh), where 116 persons died on 2nd July 2024.

In order to better understand the traits of stampedes, data on multiple major stampedes that happened in India over the last several decades between 1999 and 2023 were gathered

from peer-reviewed literature (Table1). This data included the date, location, type of stampede, approximate crowd size, source of the stampede, and the number of fatalities and injuries.

**Table 1:** Human stampedes in India identified from literature (1999 –2023).

| S. no. | Yr. | Place &State | Estimated crowd | Dead | Injured |
|---|---|---|---|---|---|
| 1. | 1999 | Sabarimala, Kerala | 2,00,000 | 52 | 102 |
| 2. | 2003 | Nasik, Maharashtra | 5,00,000 | 33 | 125 |
| 3. | 2004 | Lucknow, UP | 15,000 | 21 | 28 |
| 4 | 2005 | Mandhar Devi temple, Maharashtra | 4,00,000 | 258 | 200 |
| 5. | 2005 | Flood relief distribution centre, Tamil Nadu | 3000 | 45 | 30 |
| 6. | 2008 | Jodhpur, Rajastan | 25,000 | 249 | 55 |
| 7. | 2008 | Naina Devi Temple, Himachal Pradesh | 10,000 | 163 | 48 |
| 8. | 2010 | Ram Janki Temple, UP | 10,000 | 60 | 100 |
| 9. | 2011 | Haridwar, Uttarakhand | 2,00,000 | 20 | 27 |
| 10. | 2011 | SP Ashram,Haridwar, Uttarakhand | 2,00,000 | 16 | 32 |
| 11. | 2013 | Ratangarh temple, MP | 10,000 | 115 | 70 |
| 12. | 2014 | Gandhi Maidan, Bihar | 5,000 | 30 | 26 |
| 13. | 2015 | Rajmundary, AP | 20,000 | 26 | 37 |
| 14. | 2022 | MVD Shrine, Jammu | 10,000 | 13 | 30 |
| 15. | 2023 | Indore, MP | 10,000 | 31 | 70 |

Incidents that keep happening at the same location over time suggest that crowd control measures need to be strengthened because the event will continue to draw large crowds.

**Figure 2** shows how stampede incidents are categorised according to the type of incident. 79% of the total number of deaths were caused by stampedes during major religious meetings, which were followed by various other events (18%) and political ones (3%).

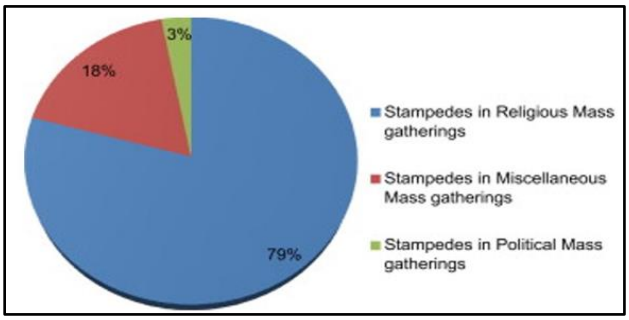


**Figure 2:** Categoriazation of incidence of incidence of stampedes

*4.2. Unrest in the crowd during a stampede: [**Figure 3-Figure 5**]*

While there is a common goal, the audiences at religious mass gatherings are made up of people of all ages and physical characteristics. People in the crowd may react unreasonably for self-defence when they perceive a threat, losing sight of other people and their surroundings in the process. Thus, a few people who choose illogical escape routes sow the seed of crowd disturbance, which eventually stifles crowd flow and spreads the perception of danger.

The dangers associated with a stampede can be categorised as either internal or external based on the case studies and literature review but the following variables could be the source of outer risks:[5]

1. **Human causes:** include terrorist attacks, exploration, and conflagration.
2. **Natural disaster**: intense downpour, flood, or seismic activity. **Facility malfunctions:** include power outages, building collapses, and lifeline cuts.
3. **Rumours**: Spreading tales of a rush, disaster, accident or other incident close to the event, as well as the giving away of free items.
4. **Competition for procurement:** People scramble to get a valuable item, job, or seat, especially if it's being offered for free. It is the main reason for most recent stampede at Hathras religious congregation, as the devotees ran for collection of sacred soil from the path crossed by religious godman.
5. **Notice of sudden change**: Prompt notification of any alterations to the location, platforms, counter, or points of entry or exit.
6. **Beginning-of-event surge or end-of-event exit:** The sudden inclination of crowds to disperse as quickly as possible after an event concludes or when any of the aforementioned elements have an effect on the crowd.

Therefore, when stampede situations worsen, the individual becomes less visible and the crowd gains control; this change typically happens in a matter of seconds. According to the "group-mind" theory, when a person is in a

crowd, he or she loses control over their own thinking and begins acting in accordance with the wishes of the group. According to Arbon, crowds become fluid and people will jostle each other if the density gets close to seven people per square metre.[3] Those who are jostled could feel lightheaded and have troubled breathing. The impact of crowd control measures on the occurrence of stampedes during mass gatherings: the Hajj experience," *Travel Med Inf Disease.* 2017;15:67-70.

*4.3. Security in places of worship*

In India, religious holidays are unique times for communal celebrations, prayer, and fasting that can extend for several days, weeks, or even months. The religious assembly on the day of the annual Pongal festival in Trivandrum, in the southern Indian state of Kerala, is the largest gathering of women for any given occasion. These festivals, which take place at any time and place, become the hubs for large crowds of young, middle-aged, and elderly individuals.

The location's susceptibility and the features that surround it have a major impact on the comfort and safety of religious mass gatherings. Religious festivals usually present a geographical risk to the pilgrims, particularly when they are held in isolated rural locations, on mountainous terrain, in the foothills, or along riverbanks without appropriate paths. Some common concerns seen at religious gathering venues include steep slopes, uneven venue topography, dead ends, slippery and muddy floors, and the convergence of pedestrian flow to a single point, which can compromise safety and cause stampedes.

*4.4. Few words on Hathras stampede, the latest in long list of stampedes:*

According to experts, the event organisers' inadequate planning for the religious gathering and the authorities' lack of experience contributed to the rush.

Experts claim that the following important elements played a significant role in tragedy:

1. **Overcrowding**: A police report filed following the incident stated that 80,000 individuals were permitted to access the venue for the meeting, which drew a total of roughly 250,000 attendees.
2. **Absence of exits**: Experts in disaster management have surmised that thousands of people attempted to jam through one exit since the tent did not have enough of them.
3. **Muddy field**: It was also mentioned that a lot of people slid on the muddy field at the gathering location, which added to the crowd crush. On top of the already muggy day, witnesses said that it started to drizzle, which led to several slips and falls.

*4.5. Reducing stampede risks during large-scale events*

Efficient risk management techniques are necessary to plan a large-scale event without putting strain on the planners or negatively impacting the community's quality of life. Mass gathering planning is an inter-agency, multidisciplinary process that starts with the identification of possible risks and ends with the creation & implementation of suitable countermeasures. In present case of Hathras mass disaster, only 80 police personals, including few traffic police personal, were present to manage a crowd of around 2.5 lakh devotees.

Therefore, in order to create the inclusive framework, the study's identified factors that contribute to the development of human stampedes. The human stampede risk reduction framework addresses the possible risks present in situations of mass crowding, with the goal of lowering the risk factor associated with mass gathering events. The framework proposes five interconnected processes for addressing, obviating and enacting safety measures during the preparation of an event.

Decision to hold the Event 2) Event Approval 3) Risk Assessment 4) Integrated

## 5. Planning Risk Reduction Measures

While an organisation starts the process of organising a large gathering event, the "concept-raising stage" examines the event's background. Before obtaining permission from the relevant authorities to hold the event, several variables, such as the event's type, venue, duration, accident history, etc., should be taken into account. The authorities must confirm the venue's suitability, the event's duration, the organization's capacity to host it, the planned safety precautions, the estimated number of attendees, etc. None of these factors were taken into consideration while organising the mass event at Hathras recently.

Accidents or unfavourable weather might be the catalyst for human stampedes (one of the major factors for Hathras mass disaster). The risk assessment team needs to take the projected crowd's diversity into account as well to the demographic factors e.g. the crowd's gender, age, level of schooling, socioeconomic status, etc. In recent disaster at Hathras, the crowd involved chiefly females from states of Uttar Pradesh, Rajasthan and Madhya Pradesh and from low socio-economic status. It started raining on the day of incident, over the crampy tent which was set on a muddy rice field.

The current disaster response strategy needs to be updated to be more inclusive if there has been a casualty at an event held at the same location previously. Prior to the event, a briefing with important stakeholders is essential to make sure that everyone is informed of the emergency management plan, the response protocols, and any potential concerns. In order to help emergency managers better

understand the efficacy of the risk management framework and enhance safety in the preparation of the upcoming mass gathering, proper recording of the event's activities and debriefing.


**Figure 3:** Improper selection of place to manage stampede with limited resources

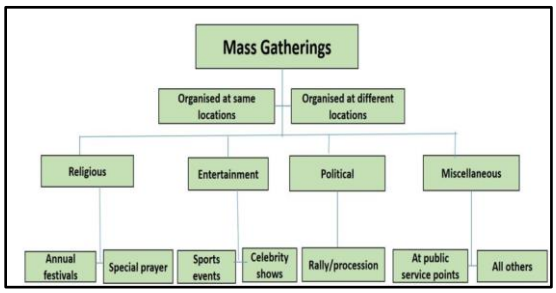


**Figure 4:** A flow chart depicting the different types of mass gathering which

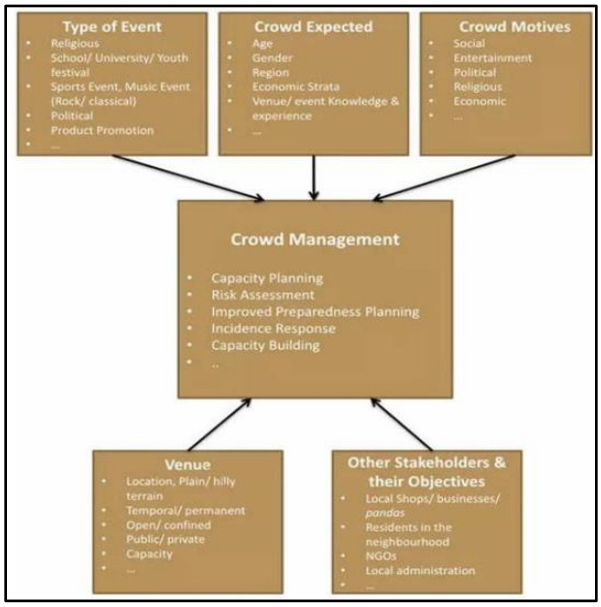


**Figure 5:** Risk reduction framework

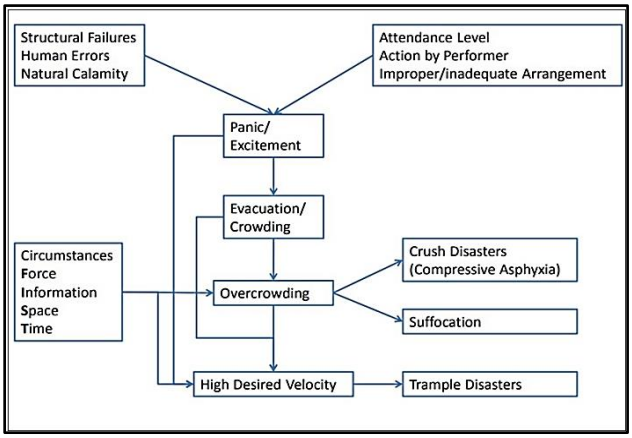


**Figure 6:** Factors contributing to stamped

## 6. Conclusion

When developing risk management techniques human stampedes—one of the most notable hazards in large scale events, have gotten little attention globally.

According to stampede data gathered for this study, religious festivals-related large-scale crowds have been responsible for of most of these events. Stampedes during religious meetings can be started by rumours, competition, rush and surge of people, or accidents.

In India, religious mass gatherings are frequently held in rural locations, which makes them more vulnerable because of inadequate venues and infrastructure. Prospective large-scale events will continue to grow in size and frequency, making it imperative to establish clear guidelines for secure application of risk management techniques. The risk management framework that the study suggests is only an initial attempt to pinpoint the variables influencing safety. In order to organise a religious mass gathering without straining society's well-being, sufficient legislative rules and mitigating measures must be brought about by extensive research on individual aspects, case studies of particular incidences, and investigation of best practices.

## 7. Source of Funding

None.

## 8. Conflict of Interest

None.

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