

# RS and GIS Based -Risk Assessment, Preparedness and Prevention of Crowd Disasters: A Case study of Religious Pilgrimage in India

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## ABSTRACT

Religious events in India often face stampedes and crowd crush. Very often the local authorities are trained at crowd control- rather than crowd management. The present study is based on the risk assessment, preparedness and prevention strategy of pilgrim site at Ujjain. UJJAIN is one of the seven sacred cities of Hindus- an ancient city since 4<sup>th</sup> C. B.C., in central India- on the banks of river Kshipra. This city is known for its great cultural and spiritual importance like Varanasi/ Banaras. It is also home to the sacred Mahakaleshwar Jyotirlinga and is the site for Kumbh mela religious festival. The nature of crowd here is varied in terms of social mix, age-range and levels of exposure to life- but the goal is common i.e. to enjoy the spiritual bliss of a God with human attributes at one of the world's largest religious congregation. The nature of offerings (water, milk, honey, bananas, flower petals and coconut) to the God coupled with the crowd craze to have *darshan* may at times enhance the possibility of a disaster. The physical features of the venue do include dead ends, locked gates, convergence of several routes into one, slippery floorings and steps and at times moving attractions within a crowd. There have been cases reported of stampedes and crowd disasters in the near past. The focus is on community disaster management strategy along with administrative officials, NGO's and personnel who interact with the pilgrims.

## INTRODUCTION

Crowds occur frequently, usually without serious problems. Occasionally venue inadequacies and deficient crowd management result in injuries and fatalities. Extreme crowding results in individual loss of control and both psychological and physiological problems. Crowding is a common experience. The crowd incidents occur in a wide variety of venues and different circumstances, the most common being – sporting events, power failure, entertainment events, food distribution, religious events, riot or bomb scare, cases of fire and so.

In January 2005, about 340 people, mostly women and children were killed in a temple stampede in Satara district of Maharashtra, perhaps the worst after the 1954 Kumbh Mela mishap in which some 800 people died in Allahabad. At the Mahakaleshwar temple in 1996 in Ujjain as early as 5 am with about 3000 persons in the temple premises and another 7000 in queue outside, a stampede occurred at feet of a staircase leading to the temple sanctum where the pilgrims rushed for worship. In September 2006, about 50 people were killed and hurt in a stampede at a sports stadium in Yemen. At a Buenos Aires night club in 2006, a fire snatched away 174 youngsters leaving another 400 injured. With all exit gates locked from outside, a stampede that followed apparently led to more deaths than the fire. In December 2005, at a flood relief camp in Chennai, 42 people died and another 50 injured in a stampede where more than 2000 people had gathered to collect relief materials. With over 2 million people assembling at Mina, Saudi Arabia every year 1990-1426 lives, hundreds of lives have been lost (in 1994 – 270 lives, 1998 – 119 lives, 2004 – 251 lives and in 2006 – 345 lives) especially during the stone throwing ceremony at 15 – metre Jamarat Bridge. Recently in August 2006, 162 persons were killed in the Naina Devi temple tragedy, when people trampled upon one another. A disaster of nearly the same dimension has struck the Chamunda Devi

temple in Jodhpur. A provisional survey shows that more persons have died in the country in religious stampedes than in terrorists – engineered bomb blasts during this year – over 360 against 156. The same has been the story in last nine years.

With stampedes killing hundreds of people every year in the country and incapacitating an equal number of them, there is an imperative need to seriously consider and put in place an effective management, control and monitoring mechanism to prevent avoidable tragedies. As an effort in this direction, the scholar has made an attempt at studying the risk assessment, preparedness and prevention of crowd disaster in the religious pilgrimage of Shri Mahakaleshwar at Ujjain where millions of people throng throughout the year.

Crowd psychology and behaviour have been studied for decades. The focus so far is on the ways to control a crowd. The principle of Sigmund Freud's theory about crowd behavior is that people who are in the crowd act differently towards people than those who think individually. The danger is that according to this theory, a person may follow other's behaviors and become less aware about the true nature of their action. Le Bon, who was considered as the founder of crowd psychology, did not agree completely with Freud. Le Bon's theory indicated that crowds foster anonymity and sometimes generate emotions. He did not consider crowds as totally irrational. Theodore Adorno criticized the belief in spontaneity of the masses. Accordingly to Adorno, the masses were an artificial product of administered modern life Edward Bernays, was one of the first to study the manipulation of the public using the psychology of subconscious.

Many of Freud's followers criticized Le Bon's concept of collective soul or collective unconscious, as the crowd has not soul of its own. The convergence theory follows this notion to consider that the crowd behavior is not a product of the crowd

itself, but is carried into the crowd by particular individuals. Ralph Turner and Lewis Killian developed the Emergent – Norm Theory of crowd dynamics. They started that people in a crowd make their own rules as they go along. Crowd behavior is never entirely predictable. The emergent – norm theory clearly shows that people in a crowd take on different roles, same as leaders, others as followers and same as inactive bystanders or opponents. According to this theory, every one plays a significant role in determining the crowd behaviors.

It is difficult to describe the psychological and physiological pressures within crowds at maximum density. When crowd density equals the plan area of the human body, individual control is lost, as one becomes an involuntary part of the mass. At occupancies of about 7 persons per square meter the crowd becomes almost a fluid mass. Intense crowd pressures, exacerbated by anxiety, make it difficult to breathe. The heat and thermal insulation of surrounding bodies cause some to be weakened and faint. Psychologists have likened a crowd to a series of intermeshing behavioral cells. Each cell is comprised of a small group of surrounding people, with limited communication between them. Cell members do not have a broad view of what is occurring in the crowd. The crowd incidents so far reported have shown different types of group motivation. In some cases there is an interruption of a simple traffic process; others fall into two general behavioural categories either a flight response or a craze. Analysis of major crowd incidents has enabled to provide a model for understanding the cause of crowd disasters. The elements of the model form the acronym “FIST”, which is a useful reminder that any crowd situation can become threatening and potentially lethal. The acronym is defined as follows: FORCE (F) of the crowd, or crowd pressure; INFORMATION (I) upon which the crowd acts or reacts, real or perceived, true or false; standing area, physical facilities – stairs, corridor, escalators; TIME (T) duration of incident, event scheduling, facility processing rates.

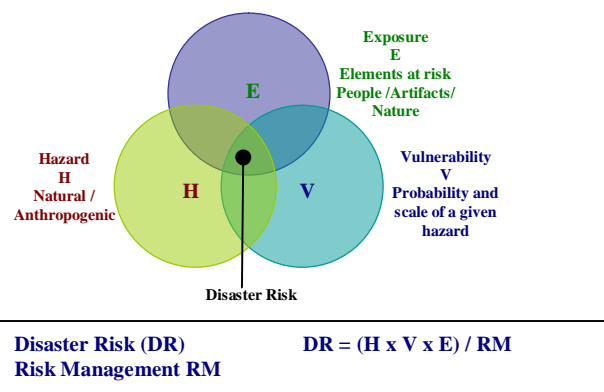


Figure-1

Risk Assessment (RA) is an estimate of the social and economic impact that hazards can have on people buildings, services, facilities and infrastructure.

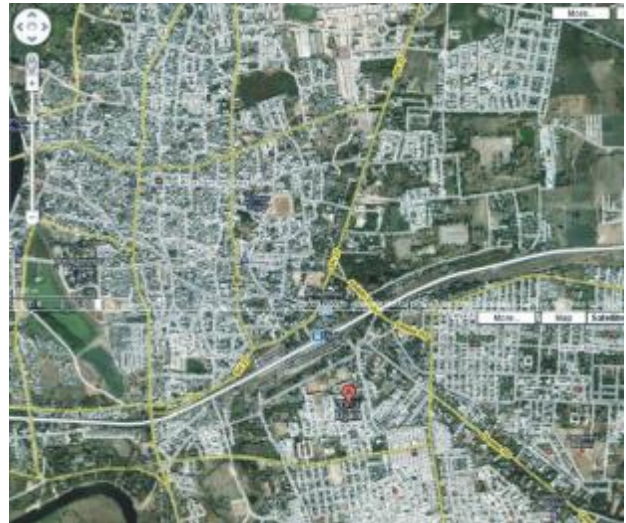
### Study Area

Ujjain is an ancient city of Malwa in Central India on the eastern bank of River Kshipra in the state of Madhya Pradesh. It is one of the seven sacred cities of the Hindus and the Kumbh Mela religious festival is held there every twelve years. It is

also home to Mahakaleswar Jyotirlinga, one of the twelve Jyotirlinga Shrines to the God Shiva. Ujjain and Mahakal are synonymous with each other.

Ujjain is located at 23<sup>o</sup>.18” and 75<sup>o</sup>.77” at an average elevation of 490 meters. As of 2001 India Census Ujjain had a population of 4.30 lakh and an average literacy rate of 72%. The economy of Ujjain is mainly dependent on the agricultural activities of the hinterland. Religious tourism is also a contributor to the economy, especially during the Simhastha (Kumbh) Mela. Ujjain is well-connected by rail and road and nearest airport is Indore at a distance of 60 Km.

### IMAGERY OF UJJAIN



Source: Google Map, 2009

Figure-2

The religious tourism to Ujjain is primarily due to Mahakaleswar Temple. It is the presiding deity of Ujjain. According to Hindu scriptures, the universe is seen as consisting of three regions – the sky, the earth and the nether. Mahakal is lord of the earth. The meaning of Mahakal is taken as lord of Time and also lord of death. It is believed that the temple of Mahakaleswar exists since the 4<sup>th</sup> century. In 11<sup>th</sup> Century the temple was renovated. The present temple of Mahakaleswar located near a lake is set upon a spacious courtyard and surrounded by massive walls. It has five levels, one of which is underground. The shikhar is sculptural finery. Mahakaleswar Jyotirlinga is situated below ground level (Garbh Grah) in the main temple. The idol of Mahakaleswar is known to be ‘dakshina mukhi’, facing the south. This is a unique feature upheld by tantric traditions to be found only here. This is the only Jyotirlinga temple where Artis are performed 5 times in a day and it is the only Shiva temple where varied forms of Shiva Sringars (decoration) are created. This temple & its premises is managed by Shri Mahakaleswar Mandir Prabandhan Samiti, Ujjain. The authorities are very profoundly supported by the local administration and police authorities.

There are more than 42 temples in Mahakal temple premises. The number of visitors on a normal day is around 25-35 thousand, which swells to around 50-60 thousand on a Monday. On special occasions like Somvati Amawasya, Naag Panchmi and the entire month of ‘Saawan’ the number of visitors cross over a lakh. During Kumbh, which lasts for a month, around 70 to 120 million pilgrims throng to this city as compared to 2

million attending the Hajj. The temple premises is spread over an area of 1.25 Hectares and at any point of time in the day these are no less than 7-8 thousand people in the temple premise. The gathering of so many people in one place at the same time leads to problems with crowd control which has the potential for disaster. With so much religious fervor in the air, and the huge number of devotees who may speak different dialects and languages, even simple communication failure can prove lead to insurmountable problems with stampedes killing hundreds of people every year in the country and incapacitating an equal number of them, there is an imperative need to consider putting in place an effective management, control and monitoring mechanism to prevent avoidable tragedies.

### Methodology

Under this study Hazard Vulnerability analysis was done by evaluating the site on the basis of potential event under the categories of Probability, Risk and Preparedness.

The issues considered for **Probability** included:

- Known Risk
- Historical Data

Issues considered for **Risk** included:

- Threat to life/health
- Disruption of services.
- Damage / Failure possibilities
- Loss of Community Trust
- Financial impact
- Legal issues

Issues considered for **Preparedness** include:

- Status of current plans
- Training status
- Insurance
- Availability of backup systems
- Community Resources.

With the help of a table ratings for each event in the area of probability, risk and preparedness, was multiplied. The total values in descending order, represented the events most in need of organization focus and resources for emergency planning. Assessing the issues of preparedness the crowd management strategies to avoid critical crowd densities was studied in depth. It was found during the study that a wide range of information about the venue and the people occupying the temple was already available.

### 1. Crowd Management Centre

A centralized crowd management and communication centre is set up right at the entrance point of the temple. The centre gets a maximum view of the venue and is constantly supplemented by video coverage and camera access to blind spaces, pressure points and all major movement pathways, full communication coordination is provided and maintained between all venue staff, local police and management authority. The direct relay of these entire close circuit cameras is accessible at the Mahakal Mandir crowd management centre.

### List of Management Equipments (Table-1)

Sr. No.	Equipments	No.
1	LCD Monitor 32"	5
2	LCD Monitor 20"	1
3	IP Camera (Rotational)	10
4	IP Camera (Fixed)	5
5	Watch Tower with Rotating Search Lights	3
6	DF MD	5
7	H HMD	5
8	B.P. Jacket	8
9	Man Pack Set	14
10	Stopper	11
11	Close Circuit Cameras	12

### Location of Cameras Installed (Table-2)

Sr. No.	Types of Cameras	Location
<b>A</b>	<b>CAMERAS INSTALLED BY POLICE</b>	
1		At D- Gate
2		Shahnai Gate
3		Vishram Dham Gate
4		Ramp
5		Chandi Grih
6		Garbh Grih
7		Nandi Hall
8		Joora Mohakal Gate
9		Temple Coutyard
<b>B</b>	<b>COMMON CAMERAS</b>	
1		At D-Gate
2		At Nandi Hall
3		At Ram Mandir
4		At Temple Courtyard
5	At Gargh Grih	
<b>C</b>	<b>MAHAKAL MANDIR SAMITI CAMERAS</b>	
1		At D-gate
2		At Shahnai Gate (Rotating)
3		At Vishram Dham
4		At Ram Mandir
5		At Garbh Grih – 1
6		At Garbh Grih – 2
7		At Garbh Grih – 3
8		At Exit gate
9		At Tempe Courtyard
10	At Nandi Hall	

### 2. Staff Training

The training of crowd management personnel is of vital concern. During the field survey it was quite evident that the responsibility of managing the crowd rests with local police along with the help of home guards, Special Armed Forces (SAF) and voluntary organizations (Community representatives) the table below gives the description of the employed security staff to manage crowd in the temple premises at any point of time – which is obviously increased in times of greater rush:

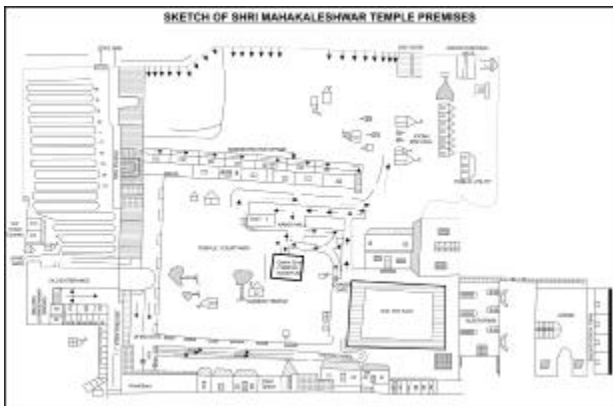
### Security Staff to Manage crowd in Mahakaleshwar Temple (Table-3)

Sr. No.	Type of Force	Insp-ector	Sub Inspec-tor	Asst Sub Inspector	Head Const-able	Const-able
1	District Police Force	1	-	2	3	12
2	District Police (Female) Force	-	-	-	1	2
3	Special	-	1	1	2	16



	Armed Force					
4	Civil Defense	-	1	-	18	30
5	Civil Defense (Female)	-	-	-	4	6
6	Total	1	2	3	28	66
7	Grand Total					100

The staff deployed at the temple premises is a team of very responsible officers who are given very adequate training to manage crowds. At no point in time casual labour is employed to manage affairs. Sufficient training is provided in recognition of potentially dangerous crowd problems and the handling of accidents and other emergencies. Training includes instructions on the basics of normal and emergency crowd movement and assembly; initial handling of accident victims; altercations and other crowd incidents; communications procedures and use of communication equipment; avoidance of actions that would incite or trigger dangerous crowd behaviours; and conduct and demeanor during an emergency. During Kumbh festival this staff gets a training spread over full one year to manage the crowd. No wonder, barring one incident in 1996 (35 deaths) there have been no major incidence of stampede or crowd rush. The deployment of this security staff is at well designed points in the temple premises. Besides the above personnel, there are several voluntary organizations registered with the managing authority who provide 100-150 voluntary (community representatives) during festivals and days of rush. Those volunteers are semi-trained and prove to be very useful in understanding the crowd's psychology and behaviour. The task of these volunteers is simple and they work for only one aim – i.e. to calm and assure the crowd.



(Figure-3)

### 3. Crowd Management Strategies

Several systems model of time, space and information are used to develop control strategies to prevent the occurrence of critical crowd forces. The objective of time based control strategies is to prevent the buildup of large accumulations of patrons in short periods of time. The physical facilities and staging is adequate to accommodate expected patron flow rates, when possible, the arrival rate of patrons is managed to prevent crowd accumulations that exceed gate processing capacity. The strategies adopted are:-

**3.1 Metering:** - This is done to control the rate of arrivals and degree of crowding at a known pedestrian bottleneck. This technique is used here at entrance gates, and ramps where an

entry of not more than 50 persons at a time. The ramps are designed as meters with police-men continuously monitoring the flow of people. The metering is done with a caution so that the waiting time of other pilgrims is not increased. In waiting time increases, anxiety increases which may lead to disturbed crowd behaviour. But definitely metering is necessary to prevent bottlenecks. In this temple metering is started right from the entrance gate up to the temple *Garbh Grah*.

**3.2 Processing Rates:** - A good sense of patron capacities and processing rates of all the pedestrian facilities and spaces is maintained. Short courts are made of ticket takers, stairs, doors, ramps and so on to ensure a smooth flow of people. Since differences in the traffic characteristics of pedestrian facilities exist for e.g. stairs have less capacity than corridors or ramps – a three story ramps structure with sufficient barricading has been developed. Very clear and distinct entry and exit gates are maintained. In times of great rush multi-entry points are operative. Even in the temple courtyard the security staff does not follow the pilgrims to stay for a large-time and repeated requests of continuous movements are made.

**3.3 Occupancies:** - Waiting areas in the ramp structure and outside the main entry gate are points of concern. Studies have shown that 20 sq. ft. per person will allow relatively free movement; 10 sq. ft. movement on an “excuse me” basis; and 5 sq. ft standing without touching others – but with little ability to move freely. At 3 sq. ft per person, involuntary touching and brushing against others occurs – it is a psychological threshold that should generally be avoided in most public situations, below 2 sq. ft per person potentially dangerous crowd forces and psychological stresses may being to develop. In this study area, it was found that due to processing rates maintained and good metering adopted, normally people are standing at 5 sq. ft per person since the craze for ‘*darshan*’ in the temple is immense, despite sufficient space available people tend to congregate closer. The waiting room is well ventilated with sufficient fans and water supply at regular intervals, but toilets are not available until at least close to the exit gates. On an average rush day – due to metering / processing rates and proper occupancies maintained – a pilgrim takes 3-4 hours to have ‘*darshan*’.

**3.4 Architectural Design:-** To prevent crowding and facilitate pedestrian movements, this place provides centralized entrances and exits for the general masses but multi-entry/exit points for the VIP and ticket holders Circuitous and narrow passageways are maintained with the help of barricades and there are no other doorways or stairs in the way to create confusions or ambiguity sufficient deployment of security staff/ volunteers ensures that people are confined to their queues and avoid any flight response in an emergency. In emergencies, “the line of sight” becomes “the line of flight”.

A point of concern in the architectural design is the flooring of the ramp. The ramp is covered with tiles which are not very high on non-skid category. As a result, there is a constant fear of slippage in times of rains and heavy rush. Although as a temporary arrangement heavy jute nothing is done. But in extreme crowd situation sometimes these mats may become a cause of accident because they are seen to be crimped and crease in leading to emergency situation.

**3.5 Communication:** - A well-planned communication network involving the staff, patrons and local police is maintained controlled by the main crowd management centre close to the

entrance gate. This is maintained with the help of radio systems for the staff and sufficient LCD Screens for the pilgrims to have 'darshan'. There 5 LCD monitor of 32" and 1 LCD monitor of 20". All these are placed at strategic points for the pilgrims to have 'darshan' continuously during their entire stay period in the temple premises. A clear chain of responsibility for crowd control and emergency procedures is well established and reinforced. There is formal designation of authority with sufficient liaison actively maintained with local police, fire medical and other emergency services. There are clear roles defined and well documented through written orders and organization charts. A direct communication with patrons is avoided during normal times because the form and wording of the message if misunderstood can produce a sense of urgency or threat to personal safety. But in times of situation of defusing a potentially dangerous crowd recommended communication techniques and typical messages are given to the staff during training sessions.

**Conclusion:**

It was found during the detailed analysis of Risk Assessment, Preparedness and Prevention of Crowd Disasters in the religious site of Shri Mahakaleshwar temple, that the event and venue is well maintained. The use of imagery helped in understanding its location and relative place in the city. The GIS technology can further be used to do an extensive survey whereby a complete emergency plan with the help of network analysis can be made with the help of utility resource mapping. A provisional survey shows that more persons have died in the country in religious stampedes than in terrorists – engineered bomb blasts during this year – over 360 against 156. This has been the story in last nine years. Keeping the above fact in mind, the prevention strategies of risk to crowd disasters is well managed in this shrine.