Strengthening of Fire Fighting Facilities in Cities

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Abstract - *Fire safety in high-rise building is now a major concern for fire fighting. The major problems associated with the fire fighting in high-rise building are the delayed response of city fire brigade at site, lack of availability of water with City Fire Brigade (CFB) & lesser digitization in Fire Service Administration (FSA). To reduce the response time of CFB, it has been proposed to connect the high-rise buildings to the city's fire station through Auto Dialer System (ADS). It will work on the principle of detection system, where if any detector is activated due to fire at any floor of high rise building, it would give signal to fire alarm Panel. Signals from fire alarm panel to ADS will be transmitted in the form of Normally Open (NO) & Normally Closed (NC) switch. After receiving signals in ADS, a pre-recorded message that includes exact fire location, locality and emergency contact person number will be forwarded to city fire station. For avoiding traffic congestion, it has been proposed to install Global Positioning System (GPS) on every Fire Tender for proper planning of route before taking Fire turnout. To overcome shortage of water and its availability with CFB during an emergency, it has been proposed to provide external hydrant at designated place by taking extra tapping on city's water supply pipe coming from water reservoir tank. To improve digitization in FSA, it has been proposed to digitize the fire inspection, audit, fire No Objection Certificate (NOC) & training programmes.*

Key Words: CFB, FSA, ADS, NO, NC, GPS, NOC

1. Introduction

Fire accident in buildings is a threatening one now days. These accidents create heavy lives and property losses. To find the reasons, frequency and giving protection to all type of buildings became challenges to the professionals.

The major concerned associated with fire fighting in high-rise building are:

➢ The delayed response of city fire brigade (CFB).

➢ Availability of water with city fire brigade (CFB) to fight with fire.

➢ Less digitalization in fire service administration (FSA).

1.1 The delayed response of city fire brigade (CFB).

On study it has been found that, this delayed response of city fire brigade (CFB) is mainly because of two reasons:

✓ Late communication to CFB team

✓ Traffic congestion

To reduce the response time of City Fire Brigade (CFB), it has been proposed to connect the high-rise building like: City complex, Shopping Mall, Coaching center, school, Colleges etc. to the city's fire station through Auto Dialer system (ADS).

The ADS system will work on principle of detection system; once any detector is actuated of any floor of high-rise building, it would give signal to fire alarm panel (MIMIC Panel) which would forward the signal to ADS in form of NO & NC. Immediately after receiving signal at ADS one pre-recorded message that includes exact fire location, Locality, and emergency contact person number would get forward to city fire station. After the message being received, city fire personal would confirm the fire-call by dialing emergency contact number and take turnout immediately.

To avoid fire tender taking wrong route, it has been proposed to install Global Positioning System (GPS) system on every Fire Tender so that proper planning of route can be done before taking Fire turnout. Both the ADS & GPS tracker system would considerably reduce the response time of CFB.

1.2 Second concerned is availability of water with City Fire Brigade (CFB) during emergency.

Water scarcity is a big challenge during combating of high-rise buildings fires by fire services. In worst fire scenarios, city fire brigade loses a lot of time in mobilizing water tenders between fire incident site and source of water like wells, rivers etc. and underground water storage tanks within the towns etc.

Lack of up keeping and decades of negligence had rendered the underground water storage tanks and hydrants unusable in cities during fire ground operations. The providing extra tapping on the water supply pipelines connected to the city water reservoir tanks can reduce the water scarcity to city fire brigade in an emergency.

The district Municipal Corporation will ensure the reliability and restoration of water refilling points in form of extra tapping's providing 24/7 water supply and sufficient pressure during firefighting operations.

1.3 Third concerned is less digitalization in Fire Service Administration (FSA).
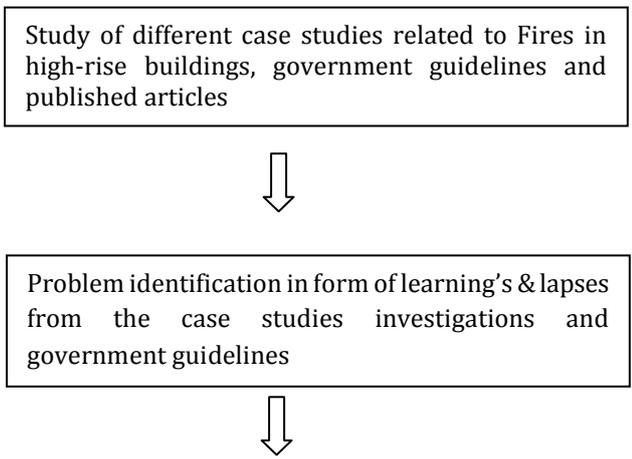
Fire service administration mainly emphasizes the management of municipal fire services, protection and prevention strategies, fire investigation, forensics, community and political dimensions of fire service administration. No Objection Certificate is issued by the respective state fire services, which verify that the building is resistant and unlikely to observe any fire related accidents. Digitalization in fire service administration is conversion of information from a manual format into a digital one for improving the system and compliance process. Thus, the three proposed system would help in strengthening the firefighting facilities of the city.

2.0 Objective of study

- To identify the lapses and propose the system to improve the delayed response of city fire brigade (CFB) at site.
- 24 hr. / day availability of water with city fire brigade (CFB) to fight with fire.
- To increase the digitalization process in fire service administration (FSA).

3.0 Methodology

The problems identified and various solutions proposed in The case study can be summarised in the form of following:

> Study of different case studies related to Fires in high-rise buildings, government guidelines and published articles

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> Problem identification in form of learning's & lapses from the case studies investigations and government guidelines

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> Proposed Solutions

3.1 Study of Different case studies

The following case studies, the National Disaster Management Guidelines: Scaling, Type of equipment and Training of Fire Services and Mumbai Fire brigade published article were also analyzed to propose solutions for strengthening firefighting facilities in cities.

Case Study 1: Takshashila arcade complex, Sarthana area, Surat, Gujarat (Surat Fire Incident 2019 - Case study and Learnings by Efficaz Consulting & Solutions)(1).

Fig - 1: Firefighting operation by Surat city Fire Brigade and engulfing smoke and toxic substances from illegal makeshift dome on Terrace of Takshashila arcade Complex.

Date & Time of fire occurred: 24.05.2019 between 3.45 - 4.00 pm.

Number of Casualty: 22 students died and 19 non-fatal injuries.

Root cause of fire: Short Circuit happened on Air Conditioner Circuit and spread of fire from ground floor to makeshift dome built on terrace.

Lapses:

Fire Brigade Arrival: As per witness, the fire brigade arrived 45 minutes late with no deployment of safety net or airbag to soften the flow of people who jumped from the top.

Design of Building: Lack of access and egress and inadequate ventilation.

Fire protection systems: No Safety equipment in building.

Fire Safety Awareness: Lack of training.

Learning:

- National Building Code should be followed for safety compliance.
- Present of loopholes in system and need of awareness among all officials.
- Getting NOC does not mean premises are safe.
- Continuous running of electrical loads contributes to fire hazard. Periodic thermography and Electrical audits helps to improve every time.
- Based on incident/accident fire and emergency services should mobilize with the right items, equipment's and tools.
- Required Safety Equipment, training and awareness on how to use them might have saved many lives.

Case Study 2: Kamala Mills Limited Fire, Mumbai (Municipal Corporation of Greater Mumbai Enquiry Report on Fire Incident at Kamla Mills Limited)(2).

Date: 28.12.2017 to 29.12.2017

Time of fire occurred: 00.22 hrs.

Number of Casualty: 14 people died.

Fig –2: Fire smoke & emission of toxic substances coming out of the roof top restaurant of 1 above pub and Mojo's Bistro Pub in Kamala Mills Compound.

How Fire Started Fire embers emanating from the fanning of Charcoal for use in hookah in Mojo Bistro Restaurant.

Lapses:

Fire Brigade Arrival: The staff of both the restaurants did not inform the fire brigade about the fire. Fire brigade received the call at around at around 00.27 hrs. As per witness fire started around 12.05 to 12.10 hrs.

Design of Building: Due to closure of fire escape of building, all people got entrapped at roof top restaurant and died of Asphyxiation.

Fire protection systems: No maintenance of fixed fire safety equipment.

Fire Safety Awareness: Lack of fire safety training to staff members.

Learning:

- Amendment in the MMC Act section 394, 471 and 472 for eating/house restaurant license with stringer provisions. Need of rigorous compliance of post licensing compliance.
- Need of completion certificate for all proposals submission.
- Compulsory self-declaration online submission and its monitoring via software.
- Fire wing and compliance wing formation in Municipal Fire Brigade.

Case Study 3: Amri Hospital Fire, Kolkata (West Bengal Fire Service Act 1950 Unpublished report of Department of Disaster Management, Govt. of West Bengal, 3. India Risk Survey 2012, Pinkerton C&I India (P)

Ltd and Federation of Indian Chambers of Commerce and Industry (FICCI)) (3).

Fig - 3: Smoke and toxic gases coming out of upper floors of AMRI Hospital building, Kolkata.

Date & Time of fire occurred: 9.12.2011 at 02:00 AM.

Number of Casualty: 93 people died.

How Fire Started: The fire began in the basement where a pharmacy and the god own were located. The area was stacked with highly combustible material such as PVC pipes, mattresses, oxygen and LPG cylinders, and even mobile (engine oil).

Lapse:

Intimation to Fire Brigade: Loss of crucial time as hospital staff had started firefighting operations on their own without informing fire brigade.

Fire brigade deployment: Fire brigade had no search lights/ladders to initiate rescue service at initial stage.

Design of Buildings: Fire brigade vehicles could not reach closer to building as approach route width had been reduced due to DG set installation. Lack of operable window in building to dissipate smoke.

Fire Protection systems: Nonfunctional of internal hydrant/sprinkler system. Fire alarm system found switched off to avoid false alarm.

Fire Safety Awareness: Lack of training of firefighting equipment in emergency.

3.2 National Disaster Management Guidelines: Scaling, Type of equipment and Training of Fire Services, April 2012 clause 2.4 "Shortcomings in present system". (National Disaster Management Guidelines, Scaling, Type of Equipment and Training of Fire Services, April, 2012)(4).

Lack of:

- Adequate modern equipment and their scaling, authorizations and standardization.

- Appropriate and Adequate funding.

- Training Institutions.

- Infrastructural facilities.

- Vulnerability Analysis.
- Public awareness.

- Uniform fire legislation in some of the states.

Creating basic infrastructure and adopting modern technologies:

Tacking water scarcity

- Tapping natural water resources.
- Rain water harvesting
- Water storage tanks
- Fire hydrants.

3.3 "Mumbai Fire brigade seeks new spots as water runs out in British-era hydrants", (Ms, Eeshanpriya.(2017) updated on 6th December, 2017 in Hindustan times: The city fire brigade had asked the Brihanmumbai Municipal Corporation(BMC) hydraulics department to identify new water filling spots across Mumbai, to refill its water tankers during an emergency. (Mumbai fire brigade seeks new spots as water runs out in British-era hydrants. Retrieved from Hindustan times, 6th Dec, 2017) (5).

3.4 Proposed System: To improve the response of city fire brigade.

On study it has been found that, this delayed response of city fire brigade is mainly because of two reasons:

- ✓ Late communication to CFB team

- ✓ Traffic congestion

To reduce the response time of CFB, it has been proposed to connect the high-rise building like City complex, Shopping Mall, Coaching center, school, Colleges etc. to the city's fire station through ADS.

3.4.1 Auto Dialer system (User Manual - GSM Dialer 911 pdf)(6).

Auto dialer is an electronic device that can automatically dial telephone numbers to communicate between any two points in the telephone, mobile phone networks. Once the call has been established the GSM auto dialer will announce verbal messages to the called party by receiving both text message and call.

The Automatic GSM dialer is an instrument that can automatically dial a fixed number of telephone numbers and deliver a message at each of the telephone numbers, with the help of any operator based on the sim card we use. The telephone numbers and the message can be stored by the user and can be modified whenever required. When this instrument is activated, it starts dialing the telephone numbers in sequence and delivers the recorded message on each of the stored numbers. The system works on GSM module

GSM Auto dialer is an exciting advanced telecommunications reporting system. Activated by almost any type of sensor or alarm voltage trigger, GSM auto dialers will instantly deliver your pre-recorded voice message or alert to any phone or cell phone in any language, locally or to any number in the world. Interfaces with any alarm panel or can be used in a Standalone operation. The GSM Auto Dialler that dials for Emergency Help when you are away used to, fire alarm, control systems using any dry contact. Different optional sensors will trip the normally open/closed dry contact on the GSM dialers to start it calling the pre-programmed phone numbers. When an alarm sounds, it will call you and play our own pre-recorded message.

SMS based Fire Alarm system are very useful in remote locations where human interaction is limited. Such systems are useful in mines, industrial areas, factories etc.

3.4.1.1 Brief Description of features

- ✓ **GSM Based** – System is based on new & advanced GSM technology. With the help of this technique user can control the system without any limit of

distance.

- ✓ **Microcontroller Based** – This system is purely microcontroller based.

- ✓ **Inbuilt static memory** – Unit has nonvolatile memory due to this mobile numbers & other parameter remain same on power ON / OFF.

- ✓ **Two Way Alarm System** – Two-way alarm system helps the user to find out the status of the system as well as set programming parameters as per his / her requirement by sending SMS and in case of any triggering / tampering in the system, user will receive messages regarding the faults in the system. In this way user can communicate with both sides.

- ✓ **Mobile No's can be stored to operate the system** – System provides the facility of storing four mobile numbers to operate the system. These numbers can be delete / overwrite according to requirement. But all these four numbers should be different.

- ✓ **Fire message & calling** – As soon as unit gets fire emergency Input, it will blow hooter, sends 'Fire Alert' SMS to all saved numbers and then call to these numbers & play recorded voice alert message for fire emergency.

- ✓ **System Status message** – User can check the status of the system. Reply SMS from unit contains the status of all the zones (like zone is ok or fault in zone), hooter time and external relay output type (call or pulse type).

- ✓ **Hooter Output provision** – Unit has hooter output provision. In case of any emergency, hooter will ON to alert the user. Hooter time can be programmed.

3.4.1.2 Installation Instructions

- ✓ Open the screws from the upper & lower part of the metal housing.

- ✓ Insert the SIM properly.

- ✓ Make sure that all the wires are properly connected.

- ✓ Then connect the unit with power.

- ✓ The system will take around one minute for initialization.

3.4.1.3 Operation of Auto Dialler system

The ADS system will work on principle of detection system; once any detector is actuated of any floor of high-rise building, it would give signal to fire alarm panel (MIMIC Panel) which would forward the signal to ADS in form of NO

& NC. Immediately after receiving signal at ADS one pre-recorded message that includes exact fire location, Locality, and emergency contact person number would have forwarded to city fire station. After the message being received, city fire personal would confirm the fire-call by dialing emergency contact number and take turnout immediately.

Fig - 4: Auto dialer Medical Alert System GSM Panic Button

3.4.2 GPS Technology (Proposal for Supply, Installation, Commissioning and Monitoring of GPS based tracking System for parliamentary elections, 2019 in Madhya Pradesh)(7).

GPS (Global Positioning System) is a satellite-based navigation system. It provides time and location-based information to a GPS receiver, located anywhere on or near the earth surface. GPS works in all weather conditions provided there is an unobstructed line of sight communication with 4 or more GPS satellites.

With signals from three or more satellites, a GPS receiver can triangulate its location on the ground (i.e., longitude and latitude) from the known position of the satellites. With four or more satellites, a GPS receiver can determine a 3D position (i.e., latitude, longitude, and elevation). In addition, a GPS receiver can produce data on your speed and direction of travel. Anyone with a GPS receiver can access the system. Because GPS provides real-time, three-dimensional positioning, navigation, and timing 24 hours a day, 7 days a week, all over the world, it is used in numerous applications, including GIS data collection, surveying, and mapping.

To avoid fire tender taking wrong route, it has been proposed to install GPS system on every Fire Tender so that proper planning of route can be done before taking Fire turnout. Both the ADS & GPS tracker system would considerably reduce the response time of CFB.

3.4.2.1 Installation of GPS tracking Devices

As per the information obtained from the "Request for proposal for Supply, Installation, Commissioning and Monitoring of GPS based tracking System for parliamentary elections, 2019 in Madhya Pradesh" clause 7.1, the installation of GPS tracking devices:

- The GPS tracking devices should be installed inside the vehicle.

- The GPS tracking devices should be provided with all relevant hardware, cabling arrangements, pre activated sim cards, memory cards.

- The GPS tracking device should be mapped with the attribute data.

- The GPS tracking device should be integrated with the web or mobile base application software.

Control room set up for real time data monitoring of the GPS fitted vehicles. It includes Laptop/Desktop with internet connectivity and Vehicle tracking software installed and running successfully.

Fig - 5: Real time GPS Tracking System Vector illustration diagram scheme with satellite, vehicle, antenna, servers and devices at istockphoto.com.

3.5 Proposed system: 24 hr. day availability of water with city fire brigade (CFB) to fight with fire.

3.5.1 City Municipal Water supply distribution system.

Water scarcity is a big challenge during combating of high rise buildings fires by fire services. In worst fire scenarios, city fire brigade loses a lot of time in mobilizing water tenders between fire incident site and source of water like natural resources like wells, rivers, etc., underground water storage tanks within the towns etc.

The water scarcity to city fire brigade in an emergency can be reduced by the providing extra tapping in form of pillar hydrant on the city municipal water supply pipelines connected to the city water reservoir tanks at all regions vulnerable to fire accidents in the city. The district Municipal

Corporation will ensure the reliability and restoration of water refilling points in form of extra tapping's providing 24/7 water supply and sufficient pressure during firefighting operations.
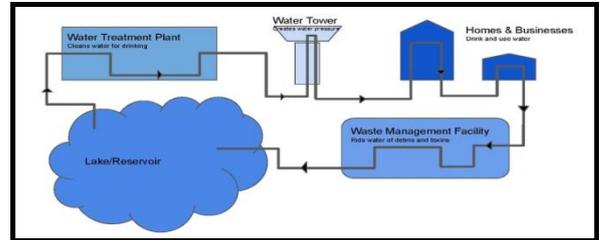

Fig - 6: USA not combined city water system(https://en.wikipedia.org/wiki/Water_supply_net work)(8).

3.5.2 Evaluating Municipal Water Supply Distribution System (U.S. Fire Administration Water Supply Systems and Evaluation Methods, Vol. 2: Water Supply Evaluation Methods, October 2008)(9).

Municipal water supply systems include facilities for storage, transmission, treatment, and distribution. The design of these facilities depends on the quality of the water, on the particular needs of the user or consumer, and on the quantities of water that must be processed. Fundamentally, a water supply system may be described as consisting of three basic components: the source of supply, the processing or treatment of the water, and the distribution of water to the users. Water from the source is conveyed to the treatment plant by conduits or aqueducts, either by pressure or open-channel flow. Following treatment, the water enters the distribution system directly or is transported to it via supply conduits.

As per recommended practice of American Water Work Association (AWWA) Manual of Water Supplies Practices M-31 and M-17 along with criteria published by the ISO in accordance with grading schedule evaluations, the greater of maximum hourly demand or maximum daily demand plus fire flow requirement is taken for design flow and analysis of Municipal water supply distribution system. Flow fire test conducted semi-annual help in determination of fire flow criteria. Layout of the Treated Water entering the water distribution system can be in form of loop configuration or branch configuration. The loop configuration is preferred as it gives water to flow in two directions. In case of maintenances, damage due to accident and cleaning activities also water can be supplied to the pillar hydrant from a different direction.

The storage of water can be done aboveground and elevated storage tanks. The above water tank capacity can be determined based on analysis of water distribution system and Net fire flow requirements. The pumping system requirements met by indirect pumping system which

operates with water level difference in elevated storage tanks to maintain difference between pump station discharge and water distribution system demand.

"**As per Evaluating distribution systems in Appurtenances, Volume 2, Water Supply Evaluation Methods, October 2008",** Piping sizing is based on sum of peak day water use plus fire flow requirements. The minimum size of water main for providing fire protection and serving fire hydrants is 6 inches in diameter.

As per clause 2 fire hydrant locations, Evaluating Distributing System Appurtenances the flow capability of fire hydrant with respect to its location to fire risk area as follows.

- Hydrant up to 1000 GPM capacity within 300 feet of fire risk building.
- Hydrant up to 670 GPM within 301 to 600 feet of fire risk building.
- Hydrant up to 250 GPM within 601 to 1000 feet of fire risk building.

The hydrant location and area can be determined as per relevant statutory requirements.

3.6 Proposed system: To increase the digitalization process in fire service administration (FSA)

The 3 major case studies of high rise buildings fires as mentioned in table 1 highlight the loopholes, lack of transparency in fire service administration due to lesser digitalization leading to high rise building fires. Increase in Fire Service Digitalization through software's can help in fast and reliable communication & compliance tracking system during different phases of a high rise buildings and will bring the building owners, state fire services, municipal authorities and state government on one digital platform. The various activities such as fire risk assessment, issue of fire service circulars online, fire NOC application & approval, fire license compliances, issue of fire norms violation notices, fire accident statistics, fire investigation reports, fire trainings scheduling & records, resident's feedback forms submission etc. can be done effectively preventing the occurrence of the high rise building fires and promoting the fire safety standards and awareness among the high rise building management, residents of the buildings and community in the vicinity.

1. As per NIST Special Publication 1191, "Research roadmap for smart firefighting" clause 1.3.1 Scope and Purpose of the roadmap, the various fire problems and challenges faced by emergency response team during emergency scenarios, the concept of smart firefighting can solve these problems which focus on data collection, data processing and delivering data to target locations. The data gathering, processing and delivering can

be done in various phases of an incident like pre incident planning, preparedness, response and recovery (NIST Special Publication, 1191, Research Roadmap for Smart Fire Fighting, Summary Report, May 2015)(10).

✓ E Fire NOC for high-rise buildings and systematic approval process during different phases of a building development or modification through a unified web based portal.

✓ All fire incidents can be reported through one unified we based portal (National, State and Local level) where the department will fill the form and forward to state for data validation and maintained in a national database

✓ The sensors like static and mobile sensors in high rise buildings, sensors on firefighter PPE, fire apparatus etc. can provide real time data that be utilized on a wireless network at fire ground operations, the data can process on computational models and the incident commander can utilize this information and take appropriate strategy to combat fires in High rise buildings. The technology behind using computational models lies in Cyber physical system. Fire service also focuses on both voice and data communications at fire ground operations using smart devices. Wireless Network can be utilized to interface the sensor devices with the wireless area network and the information can be stored on cloud server and data can be processed and delivered. GPS and GIS can be interconnected through a centralized emergency control center to provide relevant information to emergency responders (NIST Special Publication, 1191, Research Roadmap for Smart Fire Fighting, Summary Report, May 2015)(10).

✓ GIS can be used for assessment of damage after outbreak of fires.

4.0 Conclusion

The proposed systems would help in decreasing the response time of fire tender by removing human intervention & would meet the additional requirement of water. Thus, the three proposed system would help in strengthening the FSA & fire fighting facility of the city.

5.0 References

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