Smart Cities and Smart Firefighting

- Ramifications for the Fire Services

- by Abhay D. Purandare

1.0 Introduction

Smart Cities and Smart Firefighting are the buzzwords amongst fire and emergency services in the country today. Though they appear to address the same issue, they actually deal with two different aspects related to fire services – one addresses the fire and emergency services requirements for smart cities (as per relevant and existing smart city standards), while the other relates to smart firefighting, which is a relatively new concept even for developed countries. Smart firefighting deals with the use of technology (mainly IT, big data, IoT & communication) in improving firefighting response, as well the standards and codes related to this (which may be applied in the future).

2.0 Smart City Standards

Smart City Standard (ISO 37120) as well as the Indian Standard (BIS) draft CED59 (10000) were developed to allow different cities to compare themselves with other cities in the country and around the world using some common indicators. These standards are almost similar in structure and matter, with the BIS draft drawing heavily from the ISO standard. These documents have brought out a list of indicators (core and supporting) for different sectors and services provided by a city (termed 'themes' in the documents). These will indicate the performance management of city services and quality of life of its citizens. Cities are expected to provide the core and supporting indicator values for each theme. It may be noted that these standards do not provide a 'cut-off' value for these indicators i.e. it will not say whether you can consider a city 'smart' based on these indicators; however it will allow different cities to compare their indicators with those of other cities. Therefore, a city can be 'relatively smart' i.e. it may be the smartest city in its country (based on these indicators) but could be far behind smart cities around the globe.

2.1. Core Indicators for Fire & Emergency Services

The sixth theme of ISO 37120, and section 9.0 of CED59 (10000) cover fire and emergency response indicators. Both documents have similar indicators; three core and three supporting indicators. The three core indicators cover number of firefighters per 100,000 population, number of fire related deaths per 100,000 population and number of natural disaster related deaths per 100,000 population.

Considering the first core indicator for our capital city, Delhi Fire Service has an operational strength (those involved in active firefighting) of approximately 3300 firefighters and a total strength of 3600 personnel.[1] They cover a population of approximately 11 Million, which works out to 33 firefighters per 100,000 population. The financial capital Mumbai, has a Fire Service with approximately 2700 personnel[2], protecting a population of approximately 18 million, which works out to roughly 15 firefighters per 100,000 population. Compare this with cities in the USA, which have an average of 167 firefighters per 100,000 population, with large cities such as New York (133) and Chicago (153) having lower figures as compared to medium cities such as Memphis (273) and Washington DC (367) [3]. European cities such as London have 60 firefighters per 100,000 population[4], while Paris has 382[5]. As is evident, there is a large gap in number of firefighters between our country and the developed world. Actually, even by our own SFAC (Standing Fire Advisory Council) recommendations, our cities are woefully short of firefighters, stations and equipment. Even our most important cities, Delhi and Mumbai, have clearly identified and serious shortfalls as far as number of firefighters and fire stations are concerned [6],[7]. There's little to say about the other cities.

The second core indicator concerns the number of fire deaths per 100,000 population. In a country where there is no national fire incident reporting system, these figures will have to come through other sources. Presently, figures related to fire deaths come from the NCRB (National Crime records Bureau) data, which may not be a very reliable source of fire

Smart City Standards were developed to allow different cities to compare themselves with other cities in the country and around the world using some common indicators incident related information. An international website on life expectancy[8] also provides country wise fire death rates per 100,000 population and shows the figure for India as 4.58 deaths. Compare this to some other counties – USA (0.75), UK (0.37), New Zealand (0.36), Australia (0.48), Germany (0.35), Spain (0.24) and Singapore (0.22). Similar figures are also available from another fire service data related body (International Association of Fire & Rescue Services – www.ctif.org).This indicator is an overall reflection of the city's focus of fire safety and concern for its citizens from the hazards of fire. Clearly, there's a lot of ground to be covered before our cities could compare with some of the known cities in the world on this indicator.

The third core indicator addresses the number of natural disaster related deaths per 100,000 population. Now this is not purely a reflection of fire safety or the fire services of a city. It reflects the emergency preparedness of a city, which should cover factors such as city layout and planning (keeping in view type of disasters expected) and other mitigation strategies, emergency planning and response agencies efficiency (which include agencies such as the NDRF and other administrative services). One source of natural disaster related data[9] for 2010-2015, indicates an average death rate of 0.2 (per 100,000 population) for India. Comparative figures for other countries are USA (< 0.1), UK (< 0.1), Germany & most of Europe (< 0.1), Sri Lanka (0.4), Afghanistan (0.8), Singapore (0.0). It must be understood that certain countries/regions are more prone to disasters and can have a high mortality rate inspite of having good preparation, Japan being a case in point which has a rate of 3.4[9].

2.2. Supporting Indicators for Fire & Emergency Services

The three supporting indicators are number of volunteer and part-time firefighters per 100,000 population, Response Time for Emergency Response Services from Initial Call, and Response Time for Fire Services from Initial Call. The CED59 (10000) states that 'In order to promote best practices, cities should also report on the Supporting Indicators given in this Standard'. However, there are no clear guidelines if these do carry any weightage or how important these are as compared to core indicators.

The first supporting indicator concerns the number of volunteer and part-time firefighters per 100,000 population. In many countries, regular or full-time firefighters are supplanted by volunteer and part-time firefighters during emergencies. There are also situations where remote areas/ regions may have only volunteer or part-time firefighters. An interesting point here is that the number of voluntary or part-time firefighters will be much more than regular firefighters in most developed countries. They add value to the fire safety of the community, as in the event of major incidents, they can play an important role by assisting the regular firefighters. It should also be noted, however, that training imparted to volunteer or part-time firefighters is the same as regular firefighters (which could be an area of concern, as current training infrastructure in the country is woefully short). The concept of volunteer or part-time firefighters does not currently exist in our country, and fire services do not have a system to call upon volunteer firefighters in case of major incidents. Considering the shortage of regular firefighters, it might actually be a good idea and some fire brigades, such as Mumbai, are trying to train volunteers in firefighting.

The second supporting indicator concerns response time of emergency vehicles from time of initial call. This would apply mainly to ambulances/ other specialized vehicles (of police and disaster response agencies) which also respond to emergencies. In many cases, these emergency vehicles do not directly function under the fire service. These values are more an indication of the emergency planning of the city (Can traffic planning allow quick movement of such vehicles?), and the city's attitude/importance to safety

Fig 1. Volunteers are plenty at most fire incidents, but they need to be suitably trained to assist in firefighting and rescue operations (Image Source: 1)

(e.g. How quickly do vehicle drivers give way to Emergency Vehicles?).Therefore, it would not be fair to view this as a reflection of the fire service setup, competence, planning or training.

The final supporting indicator is the response time of fire services from initial call. This is the time elapsed from when the call is recorded to the time when the fire services reach the incident site.

"Fire service response times vary greatly from country to country. Average response time in the USA is about 6.4 minutes for urban areas, 6.5 minutes in the UK, < 7 minutes in Canada, while Denmark, France, Greece, Ireland, Norway and Sweden had acceptable urban response times of 10 min (it may be noted that in certain developed countries, the initial firefighting is carried out by occupants and longer response times are actually acceptable). Our own SFAC (Standing Fire Advisory Council) recommends a time of 3, 5, and 7 minutes respectively depending on risk category A, B, and C in urban area, which are practically very difficult to achieve. As with the previous indicator, a large number of factors contribute to this figure, important among them being the fire safety strategy employed by the community/country, the emergency (traffic) planning of the city, efficiency and skill of the Fire service drivers and attitude and awareness of the people towards safety, etc.

3.0 A Silver Lining?

'Every cloud has a silver lining' goes the saying. Neglect by successive governments towards the problem of fire safety and the issues related to fire services in the country have resulted in a situation that is worrisome. Except for the metro cities, and a couple of states, the fire services have not got the importance they deserve, and have failed to develop on par with other countries. As per the National Disaster Response Force and Civil Defence website, urban fire services suffer deficiencies of 72.75% in fire stations, 78.79% in man power and 22.43% in equipment. It goes on to state that 'a large number of State Fire Services do not even have adequate conventional fire fighting appliances like Water Tenders, Portable Pumps, etc. To provide fire fighting cover in urban areas and extending timely fire cover in an emergency in a remotely located area is hardly possible'.

The smart city movement provides an opportunity to the fire services to correct some of the above anomalies. It provides them with a clear opportunity to project the present condition of the services

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Fig 2. Present traffic conditions and traffic awareness need to be drastically improved to improve emergency response times (Image source: 2)

and the gaps which exist in comparison to standard fire services in developed and developing countries. Using the core and supporting indicators, there should be a concerted effort to highlight the shortcomings faced and ensure that sufficient effort and funding is allocated to remedy these problems. Considering the push by the government for 'smart cities', there should be a concerted movement by the fire services to utilize the same to project genuine problems and upgrade themselves.

4.0 Smart Fire Fighting

The term 'smart' firefighting is relatively new for firefighters. At the same time, it is well known that the more information firefighters have when they arrive at the fire scene, the more focussed and effective their tactics can be. Typically, information that fire services would like to have before reaching an incident scene includes, the type and size of fire (material involved, stage of fire growth), layout of the floor and compartments, type and location of firefighting equipment in the building, number of occupants in the building and their status, etc. Dynamic information such as weather, status of fire growth and its effluents, position of firefighters in the building are critical at an incident. Processing available data and converting it into useful information is the essence of smart fire fighting.

4.1. Some History

Fire Services have experimented in the past by trying to store relevant information such as building plans in electronic form, for retrieval at an incident. Some British Fire Services used microfilm to store building plans in the 90s. However, with technology and communication systems not being developed enough, it was a challenge to transfer and analyse data to the incident scene; but not any longer.

In the USA, an experiment was conducted in 2005 by NIST with the Wilson Fire & Rescue Services in North Carolina. This focused on seeing how relevant information related to fire and emergency response could be relayed to first responders on their way to a simulated incident, with the objective of improving decision making[10]. This experiment used data from three sensors in the target building: smoke sensors, heat sensors, and CO detectors. The sensor data was used by a zone model to simulate fire development and predict future conditions. Other information such as layout of hydrants and other fire equipment could also be relayed to the first responders on a device such as a laptop even as they travelled to the incident site.

4.2. Present Status

A number of new cyber information technologies are being used in a large variety of applications such as manufacturing, weather forecasting, health care, etc. These combine the cyber and physical space and are hence called cyber-physical systems (CPS). These systems provide a wide array of real-time sensor data from the community, buildings, fire fighters, equipment, and fire apparatus which can be used not only during an emergency event but also before the incident (e.g., code enforcement, prevention, training) and after it (e.g., overhaul, salvage, investigation)'. This data has the potential to enhance fire protection and situational awareness on the fire ground and, together with information from cloud-based databases, will provide valuable input for computational models and decision tools. The result will be better predictions of the likely evolution of an incident, leading to better tactical decisions'[10].

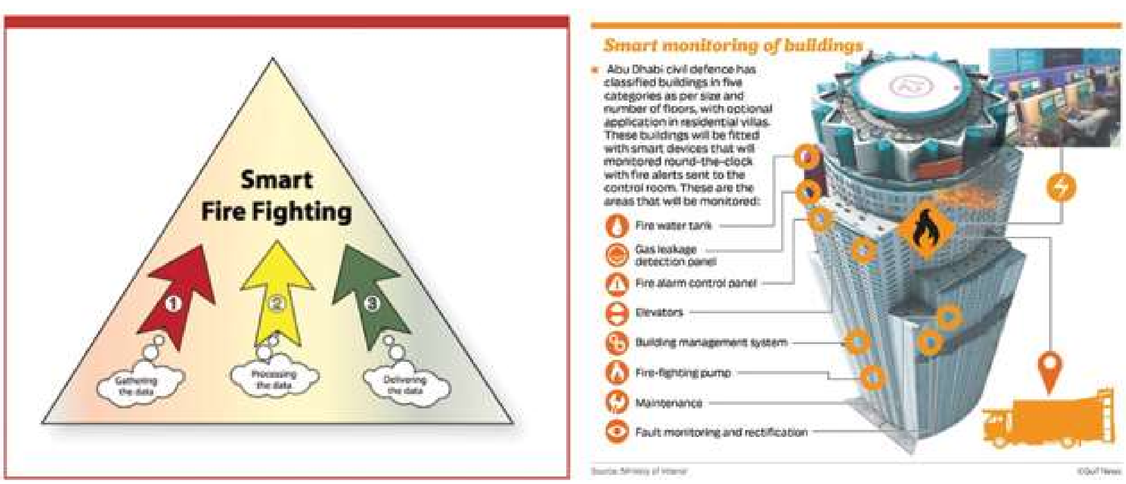

Fig 3.The essence of smart fire fighting (left) and an example of how existing BIM systems can provide relevant information to responding firefighters (right) (Image Source: 3, 4)

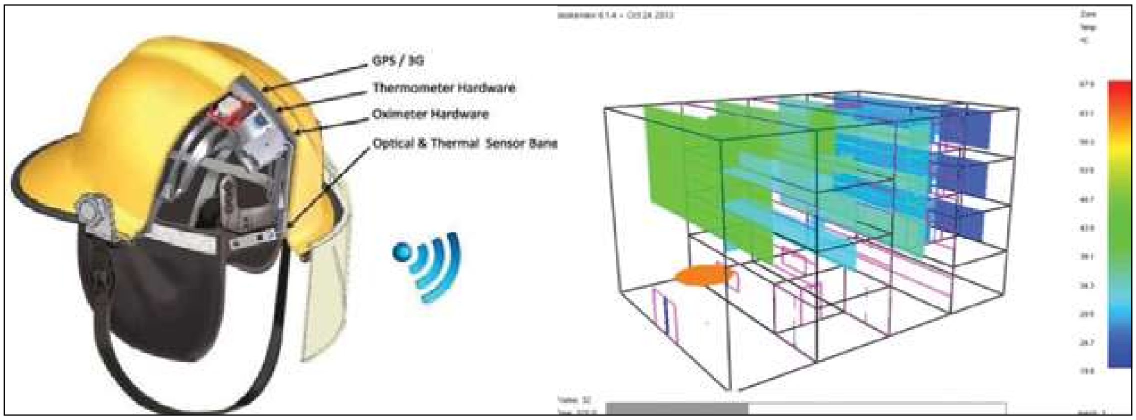

Fig 4. Critical tenability and fire data can be transferred from sensors located in firefighter helmets (left), while simple zone (fire growth) models (right) can be used to predict fire conditions and provide useful information for informed decision making. (Image Source: 5, 6)

This has been possible, largely due to the development in different types of sensors, which are becoming cheaper and more powerful. Sensors convert the characteristics of the physical environment involved in a fire emergency into raw data, thereby initiating the process of transforming what is perceived into actionable information. Fire simulation models can use higher computing capacities to better predict fire growth and spread. The development of powerful and small sized computing devices (including smartphones) allows easier analysis and transfer of large amount of data.

4.3. The Future

Smart Fire Fighting has the potential to upgrade traditional fire protection strategies and fire-fighting practices by flow of critical information where and when it is needed. While IT, communication and sensor technology are essential for this, there is still research required to understand how best to acquire, synthesize, and visualize information to support fire fighters using current and future technology. The need is therefore, to develop standards and similar guiding documents, which will provide required guidelines for future development. Performance metrics, standards and evaluation and validation methods for smart systems need to be developed.

Compatibility needs to be established for multiple communications protocols, to enable communication between different operating platforms (between personnel, between fire ground units, between incident commanders, multi-jurisdictional, etc.). Similarly, sensor technologies need to be compatible and interoperable, whether they are on-board personnel, on other equipment, or built in with the BIM systems. And then, there's the challenge of making concerned personnel aware and competent to use these technologies and systems effectively. These issues need to be addressed before smart fire fighting becomes a reality.

5.0 Conclusion

In spite of the serious shortfall in fire stations, equipment and manpower in the country, there is no reason why new technology cannot be applied to improve firefighting response and ensure safety of firefighters. With new sensor technologies, GPS, high computing power and versatile communication devices, there are numerous ways in which relevant information can

A number of new cyber information technologies provide a wide array of real time sensor data from the community, buildings, fire fighters, equipment and fire apparatus which can be used not only during an emergency event but also before the incident and after it be made available to firefighters on an incident site, making their response more effective. A number of companies and vendors are offering new technologies and systems, which have the potential for application in firefighting and rescue incidents. Within the ambit of 'smart' city project, some civic bodies are actually looking at improving communication and response times of fire services through new technology and communications. This situation provides a unique window of opportunity to the fire services to project their needs, and avail the benefits of new technology to improve their response and in turn, their status as critical and effective emergency service providers.

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Abhay Purandare is a Master in Fire Prot. Engg from the University of Maryland, and a Fellow of the Institution of Fire Engineers (UK). With experience of over two and half decades in both industrial & infrastructure sectors, he presently offers his services as a Fire & Life Safety Consultant.
abhay.purandare@gmail.com