THE LOOPHOLES OF EVACUATION PROCESS IN THE SRI LANKAN HEALTHCARE SECTOR

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ABSTRACT

Healthcare facilities are traditionally seen as places of sanctuary and safety by the general public. The fire hazard is one of the challenges faced by any healthcare organization. Therefore, in order to save lives and reduce injuries, well-designed evacuation process is significant. Thus, this research investigates the loopholes of the evacuation process in the Sri Lankan healthcare sector which, would be helped to improve the evacuation process in hospital buildings in Sri Lanka near future. The research study was initiated with a comprehensive literature review and subsequently adopted a qualitative research approach to investigate the research phenomena. Semi-structured interviews were conducted with fire safety professionals to investigate the requirements and parameters of the evacuation process and the loopholes of fire evacuation process in Sri Lankan healthcare sector. The collected data was analysed through content analysis by manual. The research findings revealed that the fire safety door, evacuation assembly point, compartmentation, fire detection and alarm system and closings of high risk rooms' doors are engaged with some loopholes which need to be improved. Loopholes contributing to evacuation process are; inadequate space in assembly points, lack of inspection by fire wardens etc. The research therefore suggests that regular maintenance, involvement of space planner from the initial construction stage, conducting training programs to staffs including managerial level, would help to improve the existing evacuation process in the Sri Lankan healthcare sector.

Keywords: *Healthcare Sector; Evacuation; Loopholes Fire Safety.*

1. INTRODUCTION

Building fire accidents result in significant life and economic losses. It is considered as one of the biggest threats to both the building occupants and its contents (Salleh and Ahmad, 2009). For an example, Ramachandran (1999) indicated that in the UK nearly 800 people were killed in the fire accidents annually, whereas direct material damage reaches to £1,200 million each year. According to Ahrens (2002) fire caused by smoking materials, heating equipment, electrical or lighting equipment in 2006-2010 were 6,240. Further, Ahrens (2012) indicated fire caused an average of six civilian deaths, 171 civilian injuries and $52.1 million in direct property damage annually. Fire safety design in a building is expected to provide a safe environment for occupants while inside the building during their safe evacuation to a place of safety where outside the building (Furness and Muckett, 2007). Obviously, the process of evacuation is significant, and therefore effective evacuation helps to save lives, reduce injuries, bound property loss and minimize all sorts of troubles that caused by the fire as wells as during the evacuation (Mileti, 1999).

There are several serious disputes when considering the evacuation of a hospital (Taaffe *et al*., 2005). For example, previous studies had acknowledged the challenges with evacuation plan, such as emergency planning and preparedness of hospital evacuation (Schultz *et al*., 2003; Manesh *et al*., 2013). As well as Taaffe *et al*., (2005) identified the issues and complexities of hospital buildings in the USA. Moreover, Schultz *et al.* (2003) and Manesh *et al*. (2013) merely described emergency planning and preparedness of hospital evacuation. Tayfur and Taaffe (2007) argued that when considering the evacuation of a hospital there are numerous critical issues identified, such as the nature of the threat, risk to patients and staff, continuing care, resource demands and threat probabilities and timing. Further, Tayfur and Taaffe (2007)

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subjected inefficient and ineffective evacuation may result in terrible loss of life. For an example, in Kolkata AMRI hospital fire killed 86 people due the lack of fire safety equipment in the hospital and also when the fire took place the windows and doors were locked (Paul, 2011). The comprehensive evacuation of hospital buildings involves different considerations (New York Centers for Terrorism Preparedness and Planning [NYCTP], 2006). Consequently, hospital premises consist with many elderly people, young people, teenagers, children, infants, handicaps and women who need both mental and physical care and medications (Bierster, 2010). The way an individual occupant in a hospital will behave to a fire danger is complex (Furness and Muckett, 2007). Evacuation of hospital is a difficult process that requires an effective strategy and careful execution, however, there is still no stable approach to tackle this problem (Tafee *et al*., 2005).

In the context of Sri Lanka, Carballo *et al*., (2005) mentioned, during an event of fire in healthcare organization, evacuation of badly injured patients were done easily because of the safety procedures which were prepared by the hospital in case of fire. However, the same researchers also argued, when hospital proposed the advanced planning and instruction for emergencies, they did not accurately and widely known about evacuation procedures. Moreover, Fazulhaq (2014) stated that although fire safety equipment is installed in Sri Lankan hospitals, sometimes there are no service contracts for the maintenance of that equipment. This conflicting nature of the evacuation process in the Sri Lankan healthcare sector identifies a research gap. The current research therefore investigates the loopholes of the evacuation process in the Sri Lankan healthcare sector, which would help to improve the evacuation process in hospital buildings in Sri Lanka.

2. LITERATURE REVIEW

Generally in the event of emergencies, a healthcare sector is a place where large number of patients need to be immediately secured (Federal Emergency Management Agency, 2007). Complete evacuation of healthcare sector requires special considerations, because a significant percentage of patients in hospitals are incapable of self-evacuation; they may be medically unstable and dependent on mechanical support equipment (Loria *et al*., 2012).

Malhotra (1993) explained that evacuation process is a vital part of any building fire protection system and generally hospital design must follow the regulation of national as well as international. Hospital building evacuation standards of the American Institute of Architects [AIA] (2006) specified about fire safety actions such as compartmenting, exits, fire alarms, automatic switch off systems, and other fire protection methods, including those within present facilities. National Fire Protection Agency [NFPA] (2006) introduced the NFPA-101 standards and declared that fire protection is based on “defend-in-place” principle. Defend-in-place principle means if evacuation becomes impossible, an alternative is to defend in place, simply most appropriate location for refuge, where it is totally enclosed. The fire evacuation requirements and the parameters for each requirement are guided by those standards. According to the literature review following evacuation requirements and parameters are identified as the requirements and parameters for an effective evacuation process.

2.1. MEANS OF EXIT

Exit route is an uninterrupted and unobstructed path of exit, which use to travel to a safe area from any emergency place and it includes exit access, horizontal and vertical exits and exit discharge (Geren, 2005). The vertical evacuation is very complex, also consuming large amount of waiting time due to the significant percentage of patients who cannot evacuate without assistances of mechanical equipment in the event of an emergency. Thus, the horizontal movement of patients is one of the most important considerations in the healthcare organizations (NFPA, 2006). Horizontal exit of the hospital should have at least two smoke free areas on each floor.

2.2. SITE ACCESS

In general, ground and air transportation are mentioned as the two types of transportations that evacuate patients to the outside the hospitals. In the healthcare sector, allocating sufficient spaces for parking is the main consideration in site access for all occupiers. Hospitals should have a separate and additional area for ambulance entrance (AIA, 2006). The size of parking lots and ambulance entrance depends on location, type and size of hospital facilities. Lee, Lim, and Anantharaman (2004) indicated that helicopter access is one of the most significant accesses which transports patients directly and rapidly from the helipad without interference from other hospital functions.

2.3. EVACUATION ASSEMBLY POINT

NYCTP (2006) stated that the evacuation assembly area is the last resort and safe point to accommodate all personnel of the building, after an evacuation. In hospitals, inside assembly area acts as the prime staging safe space and also all occupants can assemble together inside the hospital (Burgun, 1994; NYCTP, 2006). At the final stage of evacuation, all patients, staff, or visitors can assemble in the outside assembly area which is a safe open area outside the building. Healthcare sector may have more than one assembly point, depending on the size of the building. It should be out of the way of responding emergency personnel (Drabek, 1999; Burgun, 1994).

2.4. VERTICAL TRANSPORTATION

A hospital may have three types of vertical transportation. They are staircases, lifts, and ramps. In healthcare organizations, the evacuation exit stairs should be designed to please the principles for internal staircases. In hospital building only staff, visitors and ambulatory patients can evacuate through the stairs (NFPA, 2006). Non ambulatory occupants are expected to remain in the building under the defend-in-place concept which those patients on the floor of fire origin being moved horizontally to an area of refuge (NFPA, 2006). A significant amount of patients critically ill in the hospitals and patients in body casts who difficult to evacuate, elevators provide the practical vertical evacuation (Bukowski, 2011).

2.5. FIRE EVACUATION DRILL

Normally in hospitals a large amount of people is occupied daily. All of them may not be familiar with the stairways and alternative exits; sometimes it may not be familiar,even for those who are working in the same building. So they enter and exit using the same entrance. In the event of an emergency, occupants might travel past to that particular entrance or exit to evacuate the building (Jones and Demers, 2001). So the use of fire drills becomes more important in situations like these, where conducting fire drills will provide an opportunity for occupants to locate and use alternative routes under non-threatening conditions.

2.6. FIRE SAFETY DOORS

In a hospital, A fire door set should be designed as self-closing and latching devices, because they have to provide more than simply fire resistance as possible to contain the spread of fire, smoke and toxic gases especially in a high-occupancy building (Chiltern International Fire, 2000). Department of the Environment, Heritage and Local Government (2006) specified that high risk rooms should be located in close position.

2.7. FIRE DETECTION AND ALARM SYSTEMS

A fire alarm system is designed to detect a fire at a sufficiently initial stage, with the aim of people who are at risk can be made safe either by escaping from the fire (Goh and Kwek, 2005). Detectors must be coupled with alarms. Alarm systems provide notice to at least the building occupants and usually transmit a signal to a staffed monitoring station either on or off site. Further maintenance of fire detection and alarm systems should be carried out monthly basis (The Electrical Safety Council, 2008).

2.8. CLOSING OF FIRE DOORS TO HIGH RISK ROOMS

Department of the Environment, Heritage and Local Government (2006) specified high fire risk rooms should be taken special care of, and thus they can be identified as laundry rooms, kitchens and store rooms. If the high risk rooms are held in open position, then there is a major chance of the fire to be spread to other areas. Thus, three levels can be divided as low, medium and high as follows.

- Low - If all the doors to the high fire risk rooms are kept in the open position
- Medium - If some of the doors to the high fire risk rooms are maintained in the open positions
- High - If all of the doors to the high fire risk rooms are closed

2.9. COMMUNICATION SYSTEM

There should be an integral process to communicate with the occupants in the building (Muszynski, 2010). In the building both occupants and facility personnel must keep copies of the plan and as well as need to learn and practice the plan. It is also useful if the details of the person who is authorized to communicate with fire brigades, the person who operates the public addressing systems for directing the occupants to move to a safe location in the building and to do necessary things when the fire brigade arrives are also added in the evacuation plan. In high rise buildings which have these protection strategies are frequently equipped with voice communication fire alarm systems that allow either a live or recorded voice announcement, or both, to provide direction to occupants. The communication method may direct the occupants about the emergency, if they have to remain in the place and await for further instructions, or to evacuate the building (Muszynski, 2010).

2.10. COMPARTMENTATION

Compartmentation is the subdivision of the building into compartments. Each compartment separated from, either by walls or floors, thereby restricting the growth and spread of fires in buildings (Furness and Muckett, 2007). As NFPA - 101 (2006) stated, the building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period. In particular, walls common to two or more buildings must resist the spread of fire. To inhibit the spread of fire all buildings must be subdivided with fire resisting construction appropriate to the size and intended use of the building. In addition, all buildings must be protected against the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited.

3. RESEARCH METHODOLOGY

A qualitative research approach was adopted as the research requires an in-depth knowledge of the evacuation process in the Sri Lankan healthcare sector. Semi-structured interviews were conducted to assess the requirements of evacuation and to identify the loopholes in each requirement and their parameters. A total of ten numbers of private hospitals was selected and interviewed thirteen professionals in the healthcare sector, which included fire safety engineers, fire safety consultants, facilities managers, maintenance engineers and intensive commanders. The organizations were considered particularly due to those hospitals covers varieties of healthcare, including primary and acute care and constraints in collecting data from government hospitals. The number of hospitals was limited to ten due to the data saturation of semi-structured interviews. The interviewees were first asked to comment on what are the requirements and parameters of evacuation that they have fulfilled at the hospital building. A framework developed according to requirements and parameters identified through literature review, was given to the each interviewee. Then the interviewees were asked to comment on the loopholes in the evacuation process of the particular building. The views of the interviews were analysed using content analysis.

4. DATA ANALYSIS AND FINDINGS

The data for the analysis was collected using semi-structured interviews from ten hospital buildings H1-H10 through a purposeful sampling technique. Table 1 represents the profile of the participants. Participants were limited to thirteen and more than one professional who engaged in occupational health and safety activities in selected hospitals were considered where necessary. Interviewees represent the different professional backgrounds such as fire safety engineering, maintenance engineering, maintenance management, facilities management, safety consultancy, and intensive commanding. 38% of the participants represent fire safety engineering, while remaining 23% and 15% of participants are from maintenance engineering, and maintenance management respectively. An equal percentage of participants 12.5% belong to field of facilities management, safety consultancy and intensive commanding.

Table 1: Profile of Participants

Building	Interviewee	Designation	Years of Work Experience
H1	I01	Maintenance Manager	10
		Facilities Manager	6
H2	I02	Maintenance Engineer	12
H3	I03	Fire Safety Engineer	30
H4	I04	Fire Safety Consultant	28
		Assistant Maintenance Engineer	7
H5	I05	Intensive Commander	5
H6	I06	Fire Safety Engineer	17
H7	I07	Fire Safety Engineer	30
		Maintenance Engineer	7
H8	I08	Fire Safety Engineer	16
H9	I09	Maintenance Manager	6
H10	I10	Fire Safety Engineer	9

4.1. REQUIREMENTS IN EVACUATION PROCESS OF HEALTHCARE SECTOR

The review of literature indicated that there exists ten different evacuation requirements for the effective functioning of the evacuation process. However, evacuation requirements used to evaluate the evacuation process in healthcare sector in Sri Lanka were limited to eight requirements and 39 parameters which almost cover the ten critical requirements identified under the literature review. The interviewees were asked to indicate "Yes" for the requirements and parameters which currently available at the evacuation process of a particular hospital, and if not asked to indicate as "No". Only three parameters are given with a three point Likert scale which ranges from 'Low to High' as stated in the literature review and obtained the response. The Table 2 indicates the framework with requirements and the parameters of evacuation with their percentage of availability within the selected hospital buildings.

Table 2: The Developed Framework for Requirements and Parameters of Evacuation Process and Their Representation in Hospital Buildings

Requirements	Yes (%)	No (%)
Evacuation Drill		
Educating the building occupants about alarm sound	100	-
Educating to building occupants to about using fire extinguishers	100	-
Notifying the building occupants to location of fire exit routes	80	20
Notifying the building occupants to location of the fire assembly point	60	40
Familiarizing new occupants with fire evacuation drill procedure	60	40
Identifying the weakness in communication system when evacuation	40	60
Arrangement for disabled people are checked	30	70
Fire drill is carried out at night times	20	80
Means of Exit		
Fire exit routes are directly connected to the last resort	100	-
Handrails are at a height not less than 100 cm	100	-

Existence of at least two exit routes in a workplace	100	-
Unobstructed fire escape routes	80	20
Fire escape stairs have straight flight not less than 125 cm wide with 25 cm treads and risers not more than 19 cm	80	20
Fire escape entrance is separate and remote from internal staircase	40	60
Existence of emergency lighting system	04	60
Communication System		
Radios have backup direct current power source (battery)	100	-
Facilities have presence of a backup communications system	100	-
Fire brigades visit and inspection for evacuation plan	100	-
Copy of the evacuation plan kept by the security center or telephone operators	80	20
Facilities have adequacy of fire brigade access	40	60
Facilities have the provision of “action in the event of fire” notices in the healthcare sector	20	80
Facilities have the provision of “calling fire brigade procedure” notices	20	80
Fire Safety Doors		
Door materials are wind- and fire-resistant	100	-
Doors of rooms for less than 50 people and more than 50 people are respectively 112cm and 122cm wide, located from each other in distance and swing out	60	40
Provision of residents bedrooms with minimum 30 minutes fire resistance door	40	60
Main doors is double swing; bathroom door is swing out; emergency room doors are swing in and out	30	70
Door designed to be kept closed have indicated sign such as: fire exit, keep door closed	30	70
Evacuation Assembly Point		
Assembly point have sufficient spaces for assemble the large number of occupants at a time	70	30
Route from the building to the assembly point contains illumination and sign-posting	70	30
Final exits lead directly to a place of safety	40	60
An outside location at least 50 feet from the building and away from roads	40	60
Safety once away from the building	20	80
Compartmentation		
Exterior walls meet the fire resistance rating of two hours	30	70
Compartments enclosed consist of both floor-to-floor and wall to- wall fire-resistant	30	70
Room partitions made of fire resistant construction material	20	80
Automatic fire detection and alarm system		
Regular Maintenance (monthly)	40	60
Closing of fire doors in high risk rooms		
If the all the doors in the high fire risk rooms are kept in the open position	Low	30
If some of the doors to the high fire risk rooms are maintained in the open positions	Medium	70
If all of the doors to the high fire risk rooms are closed	High	-

Considering the % response regarding the each parameter of evacuation, the research findings imply, only 9 parameters (25%) are available at all the selected hospitals (100%)among the given 36 number of parameters. Consequently, 6 parameters (16.6%) from the rest of the parameters are available at the hospitals in a 70-80%. Other 17 parameters (58.3%) are available at the hospitals in a 60 or less than 60%. The last evacuation requirement is closing doors in high risk rooms. It includes three parameters and tested using a three point Likert scale. According to the interviewees' opinion, 70% of selected hospitals maintain medium risks if some of the doors of higher fire risk rooms are maintained in open positions. The remaining 30% maintains low risks if all doors in the higher fire risk rooms are kept in the open position.

4.2. LOOPHOLES IN THE EVACUATION PROCESS IN HEALTHCARE SECTOR

The next stage of the data analysis includes the analysis of interviewees' responses on loopholes in the evacuation. The interviewees' responses on the loopholes were weighted according to the parameters which have 60 or less than 60% of availability of requirements and parameters of the evacuation. According to the interviewees' opinion, this includes the loopholes in fire safety doors, evacuation assembly point, compartmentation, automatic fire detection and alarm system, and fire doors in high risk rooms.

FIRE SAFETY DOORS

Overall, two loopholes are identified in the provision of the resident's bedrooms with minimum 30 minutes fire resistance door. The loopholes include absence of conducting inspections to check the ability of 30 minute fire resistance and lack of knowledge and skills of management personnel relating to fire safety. Most of the interviewees (60%) opined that there are no any inspections to check the ability of 30 minute fire resistance. Considering the loopholes in the parameter; the main door double swings, bathroom doors is swinging out, emergency room doors are swinging in and out, and there are two loopholes responsible. 60% of the views expressed that fire safety engineers do not consider the fire door standards in selecting the door types. Another 50% of the research participants are of the opinion, lack of knowledge about the requirement of different types of doors. As the loopholes in the parameter; door designed to be kept closed has indicated sign, most of the interviewees (80%) opined that there seemed a lack of regular inspection of door whether the signs are properly displayed. And 50% of the interviewees pointed out that fire wardens are not instructed to inspect the fire doors by the hospital management.

EVACUATION ASSEMBLY POINT

The analysis indicated that the absence of fire safety engineers in the design stage, inadequate space to accumulate whole occupants in final resort and lack of awareness of fire safety standards are the most prominent loopholes for the parameter; exits lead directly to a place of safety. Approximately, 50% of interviewees were agreed on these factors. Considering the next parameter with loopholes, the parameter; an outside location at least 50 feet from the building, and safety once away from the building mainly depends on car park close to the hospital, inadequate space to design the assembly point 50 feet away from building, absence of fire safety engineers in the design stage, lack of awareness of fire safety standards, and design standards. Among those factors, 40% of the interviewees depicted that hospitals with the car park close to the building may increase the probability of accidents when evacuate the building. In terms of safety once away from the building, 60% of the interviewees indicated that inadequate space to design the assembly points inside the hospital premises is more challenging. 40% of the interviewees specified that the unawareness of the designers about the level of danger faced with placing the assembly point outside.

COMPARTMENTATION

Most of the interviewees (60%) opined that the exterior walls constructed by non-fire resistant materials, but the high initial cost of fire resistant material is challenging. Other 40% of the interviewees are of the opinion that lack of the safety tests being conducted according to the fire safety standards and lack of consideration by management in fire rating hours in exterior walls are most challenging. Considering the parameter; compartments enclosed consist of both floor-to-floor and wall-to-wall fire-resistant, the loophole is the lack of consideration of fire safety standards during early stage of the design and construction stage. This was opined by approximately 50% of the interviewees. The analysis also found out that room partitions with non-fire resistance material, lack of advice from quality consultants is more challenging on the room partitions made of fire resistant construction material.

AUTOMATIC FIRE DETECTION AND ALARM SYSTEM

In the automatic fire detection and alarm system, there are three loopholes; a few maintenance staff to carry out the inspection every month, lack of awareness of proper maintenances and testing system and

failure to maintain records relating to the fire detection and fire alarm test as per the standard. Most of the interviewees (60%) are of the opinion, that there are few staffs to carry out the inspection every month. Another 40% of the interviewees stated that there is a lack of awareness on proper maintenance and testing system.

FIRE DOORS OF HIGH RISK ROOMS

Considering the fire doors of high risk rooms, 60% of the interviewees indicated that unawareness of management and fire wardens about the importance of maintaining high risk rooms closed as a loophole in the evacuation process. Another 30% of the interviewees in the opinion that high frequency of usage of high risk rooms such as store room, kitchen and laundry and lack of daily inspection by fire wardens in high risk rooms are also contributing to the loopholes in the fire evacuation process in the Sri Lankan Healthcare Sector.

5. DISCUSSION

Building fire safety can be divided into five major steps, those are minimizing the chance of fire, early discovery, restricting the fire spread, extinguishing the fire, and evacuating the building (Smariga, 1965). Accordingly, the research identified eight evacuation requirements for the better functioning of building fire safety. The evacuation requirements are evacuation drills, means of exits, communication system, fire safety door, evacuation assembly point, compartmentation, fire detection and alarm system and closings of high risk rooms' doors. Loria *et al*. (2012) explained that a complete evacuation of healthcare sector requires special considerations, because a significant percentage of patients in hospitals are incapable of self-evacuation; they may be medically unstable and dependent on mechanical support equipment. However, research findings indicated that most of the evacuation requirements (5 out of 8) are with loopholes in the Sri Lankan healthcare sector. Those requirements include: fire safety door, evacuation assembly point, compartmentation, fire detection and alarm system and closings of high risk rooms' doors.

Evacuation aims at a continuous path of travel to move massive victims from any point within a building or structure to another open space (fire assembly point) which should be secured from danger (Lathrop, 1997). Therefore, the fire assembly point should be away from roads, walkways and 50 feet from the building. The interviews revealed that the assembly points are located even within 50 feet of building and also closed to car parks. This is because of inadequate space of hospitals. Fire safety is a process that should start at the beginning of the design of a building and it should address issues such as means of escape, smoke control and other life safety provisions (Hoffmann and Steenbakkers, 2005). This seems that the fire safety engineers and space planners need to involve from the initial stage of the design. However, the view of the interviewees (30%) indicated that the hospitals are lacking in appointing such professionals from the initial stage. A fire door set should be designed as self-closing and latching devices, with fire resistance because they have to provide more than simply fire resistance as possible to contain the spread of fire, smoke and toxic gases especially in a high-occupancy building (Chiltern International Fire, 2000). According to interviewees, the fire doors are having some loopholes like; signs are not displayed properly on fire safety doors, lack of inspections by fire wardens, and lack of knowledge of fire safety standards. Department of the Environment, Heritage and Local Government (2006), specified high fire risk rooms of laundry rooms, kitchens and store rooms, should be taken special care and need to keep in closed condition as the chance of getting fire is high. However, the research found that closing of high risk room engages following loopholes; the frequency of using those rooms per day is high, therefore it is not possible to keep closed position.

Thus, the research identifies that the fire evacuation of hospitals in Sri Lanka is engaged with some loopholes and intends to suggest ways to improve the evacuation process in hospital buildings in Sri Lanka. The next section concludes the research and provide recommendations for the enhancement of the evacuation process of hospitals in Sri Lanka.

6. CONCLUSIONS AND RECOMMENDATIONS

According to the research findings, the evacuation requirements like fire safety doors, evacuation assembly point, compartmentation, fire detection and alarm system and closings of high risk rooms' doors are engaged with some loopholes. Those loopholes need to be improved for a better functioning of the evacuation parameters. Loopholes contributing to evacuation process are; inadequate space for assembly points, lack of inspections by fire wardens and high cost involvement for fire resistance materials. The research also found that regular maintenance (monthly) of fire detection and alarm system is necessary for the best performance. However, because of the allocation of few staffs, the maintenance is not done regularly. The research recommends the strategies to improve the evacuation process through identifying the ways of minimizing loopholes. Steps need to be taken to carryout proper maintenance to fire detection and alarm system, communication system and emergency lighting system in an accepted time interval. Adequate staffs need to be allocated throughout the evacuation process. Further, the research found that record keeping of evacuation drill, maintenance of fire detection and alarm system need to be done in a systematic way. The space planner and fire safety engineers need to be involved from the design stage of the building. This could allow the building to have separate staircases for common use and in the event of fire; providing assembly point inside the building premises; and designing the parking area with sufficient width. The most significant suggestion made by the interviewees was to make the management aware of the important aspects of the evacuation process in healthcare organizations. This includes the importance of designing a fire staircase separately, regular inspection by the fire brigades regularly and use of fire resistant materials in the construction of buildings.

Finally, the research suggests that conducting workshops, training programs and brainstorming sessions regarding evacuation process and its maintenance to relevant staffs including managerial level could enhance the evacuation process. In addition, staffs from senior management levels need to undertake comprehensive training and instruction in relevant fire safety legislation and associated fire safety technical guidance. This could secure organizations from any legal problems. Thus, the healthcare sector could be seen as a place of sanctuary and safety by the general public.

7. REFERENCES

Ahrens, M., 2012. *Fires in health care facilities.* MA: National Fire Protection Association.

American Institute of Architects (AIA), 2006. *Guidelines for Design and Construction of Health Care Facilities.* Washington: American Institute of Architects.

Bierster, G., 2010. *Improving Fire and Life Safety in Hospitals.* New York: Fire Department.

Bukowski, R.W., 2011. Incorporating elevators and escalators into emergency evacuation models. *Fire and Evacuation Modelling Conference*, Baltimore: Rolf Jensen and Associates.

Burgan, J.A., 1994. *Introduction to health care planning, design and construction.* Illinois: American Society for Hospital Engineering.

Carballo, M., Daita, S., and Hernandez, M., 2005. Impact of the Tsunami on healthcare systems. *Journal of the Royal Society of Medicine*, 98(9), 390-395.

Chiltern International Fire, 2000. *Fire Doors for the Health Sector*. High Wycombe: Chiltern International Fire.

Department of the Environment, Heritage and Local Government, 2006. *Building Regulations 2006*. Dublin: Stationery Office.

Drabek, T.E., 1990. *Disaster-induced Employee Evacuation.* USA: Institute of Behavioural.

Farahat, T., 2012. Joint commission international accreditation; frequently asked questions. *National Guard Health Affairs*, 4(1), 7-15.

Fazlulhaq, N., 2014. *Important Fire Service can't Enforce Safety Rules*. The Sunday times, 2nd February.

Federal Emergency Management Agency (FEMA), 2007. *Risk Management Series Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds.* Washington: FEMA.

Furness, A.and Muckett, M., 2007. *Introduction to Fire Safety Management.* Burlington: Butterworth-Heinemann Publications.

Geren, R.L., 2005. *Means of Egress*. Arizona: RLGA Technical Services LLC.

Goh, D.andKwek, M.,2005. *Overview of Fire Alarm Systems and Maintenance.* Singapore: Fire Safety Managers' Association.

Hoffmann, N. and Steenbakkers, P., 2005. Alarm & evacuation. *Fire Prevention & Fire Engineers Journal*, 18, 1-12.

Jones, J.C. and Demers, D.P., 2001. *Emergency Evacuation Drills.* Quincy: National Fire Protection Association.

Lathrop, J.K., 1997. *NFPA fire Protection Handbook 18th edition, Concept of Egress Design*. Quincy: National Fire Protection Association.

Lee, J., Lim, S.H.,and Anantharaman, V., 2004. Helicopter evacuation: The Singapore general hospital experience. *Hong Kong Journal of Emergency Medicine*,11(4), 212-219.

Loria, G., Choudhry, N., and Sharma, K., 2012. Fire management in hospitals.*Apollo Medicine*. 9(1), 74–76.

Malhotra, H.L., 1993. *Proposed Code for Fire Safety in Buildings for the State of SaoPaulo.* Sao Paulo: British Consulate.

Manesh, A.K., Ortenwall, P.,and Nero, C., 2013. Hospital evacuation: Planning, assessment, performance and evaluation. *Journal of Emergency & Disaster Medicine*, 2(1), 18-26.

Mileti, D.S., 1999. *Disasters by Design: A reassessment of Natural Hazards in the United States*. Washington, D.C: Joseph Henry Press.

Muszynski, A., 2010. *Communication Key to Successful Fire Evacuation Plan*. USA:Trade Press. Available from:http://www.facilitiesnet.com/firesafety/article/Communication-Key-to Successful-Fire-Evacuation-Plan--11640[Accessed 15 June 2014].

National Fire Protection Agency (NFPA), 2006. *NFPA 101: Life Safety Code*. Quincy, MA: National fire Protection Association.

New York Centers for Terrorism Preparedness and Planning (NYCTP), 2006. *Hospital Evacuation Protocol*. New York: New York Centres for Terrorism Preparedness and Planning.

Paul, S., 2011. *Hospital fire kills at least 84 in eastern India* [Online]. NY, Reuters News Agency Available from: http://www.reuters.com/article/2011/12/09/us-india-fire-idUSTRE7B80EH20111209[Accessed 30 July 2014].

Ramachandran, G., 1999. Fire safety management and risk assessment. *Facilities*,17 (9-10), 363-377.

Salleh, N.H.and Ahmad, A.G., 2009. Fire safety management in heritage buildings: The current scenario in Malaysia. *In:22nd CIPA Symposium*, Kyoto 11-15 October 2009. 11-15.

Schultz, C.H., Koenig, K.L., and Lewis, R.J., 2003.Implications of hospital evacuation after the Northridge, California, Earthquake. *The New England Journal of Medicine*, 348, 1349-1355.

Smariga, J., 1965. *Fire prevention in hospital*. Washington: Public Health Service.

Taaffe, K.M., Kohl, R.,and Kimbler, L.D., 2005. Hospital evacuation: Issues and complexities. *2005 Winter Simulation Conference*, Clemson: Department of Industrial Engineering, 943- 950.

Tayfur, E. and Taaffe, K., 2007. Allocation of resources for hospital evacuation via simulation. *2007 Winter Simulation Conference*, Clemson: Department of Industrial Engineering.

The Electrical Safety Council, 2008. *Fire detection and Alarm System Inspection and Servicing Report.* London: Electricity Safety Council.

World Health Organization, 2010. *Safe hospitals in emergencies and disasters*. Geneva: WHO Press.

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