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Recommendation in Government Hospital Buildings in Context of Means of Escape based on Other Countries Cases

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Abstract: The guidelines on hospital safety been developed with a target to increase the safety of a hospital structurally and functionally and decrease the risks to human's life. The current government hospitals are mostly been built before these guidelines been developed. There are many factors that put hospitals and health facilities at high risk which includes buildings, their location, design specification and patient. For this paper, researcher's aim is to focus on the current design specification on other countries cases and compare it with the selected government hospitals. In this paper, literature study been done thoroughly on the hospitals and cases which is caused by a poor design. Hospital may differ in area of a small hospital with a less beds and no emergency facilities or city hospital with emergency facilities including extra care, diagnostics service and hundreds of beds. Therefore, designers need to understand how each hospital operates. The latest case in our country in March 2018 is the one that occurred at Hospital Kuala Lumpur. The accident occurred at the forensic department which is caused by short circuit at its store. The fire spread very quick and destroy a portion of the forensic department. The latest incident which occurs in Hospital Sultanah Aminah (HSA) on 28th June 2020. The fire involves the oxygen panel, call bell, vacuum and switch at the bed number five. There is one more case which occurred on 26 October 2016 at Hospital Sultanah Aminah (HSA).

Keywords: Hospital, fire safety, means of escape, fire design requirement

1. Introduction

The purpose of this paper is to increase the safety of a hospital structurally and functionally to increase the safety of the hospital itself by recommending a solution to government hospital based on other countries cases. The hospitals are complex and is not only to provide medical services for the patients [1]. Safety of the patient when accessing the services is the one which need to be highlighted. Good design requires an understanding for the patient, maintenance of critical facilities and because of the presence of patients whose movement cannot be anticipated, fire safety in hospitals poses some major challenges to designers and fire safety practitioners. There is also a reasonable assumption in the community that hospitals will be secure places for the treatment and care of someone who is vulnerable, with such a high level of confidence in their wellbeing whilst in the hospital [2]. Supposedly, designers need to be more aware with the current trend and all the important aspects before start to design the hospital building [3]. The reason why this research been done is because, there are a lot of fire cases occured in our country. By having this research done, fire cases in our country can be decreased by following recommendation given by researcher based on other countries cases.

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2. Literature Review

2.1 Introduction

When it comes to design, of course the one involved is architects. For sure architects do not have an ample of time for them to involve in the technicalities of the fire process. Architect usually do not wish to be a fire scientist. However, in order to maintain a proper degree of fire protection without allowing it to control the design, they must be aware of and engaged in the implementation to be aware of what occurs in the event of a fire [4]. Architects must consider their design goals and how to accomplish them, and how they need to design to achieve the objective. Therefore, this literature review will explain some parts that designers should know and make them one of the important factors of the design process. Not mainly focussed at the architect, any other professionals who have been assigned the job to design the hospital should know all the fire process.

2.2 Fire Science

On this section, researcher will describe the main stages of a fire, including ignition, fire development, heat, and smoke. Some of the technical words are described so that the designer can understand them and can go with the same understanding of the fire scientist. It will be easier for the designers to understand about the fire process and for them to discuss the design with the local authorities [5]. A low understanding level on this part will cause them to design without considering this part and lastly directs to unexpected fire accident [6]. More money will be used to repair and rebuild the damaged part of the building. It is better to plan and prevent it from the early stages compared to repair and reconstruct the damaged part after the accident occur.

2.2.1 Ignition

Combustion is a chemical reaction between the combustion of fuel and oxygen, which is normally obtained from air, results in the release of heat and light. For combustion to take place, oxygen, heat, and a source of fuel must all be present, and the absence of any of these three sources would cause the reaction to stop from occurring [7]. These three fire ingredients are so important that they're referred to it as the triangle of fire.

2.2.2 Fire Growth

Conduction, convection, and radiation are the three basic mechanisms of heat transfer, and all three are used often in the construction of fires [8]. Conduction is the form of heat transfer through solids; it also occurs in liquids and gases, although it is normally obscured by convection. Convection is defined as the movement of a medium and is limited to liquids and gases. Radiation is a form of heat transfer which does not require an intervening medium between the source and receiver as stated in Figure 1.

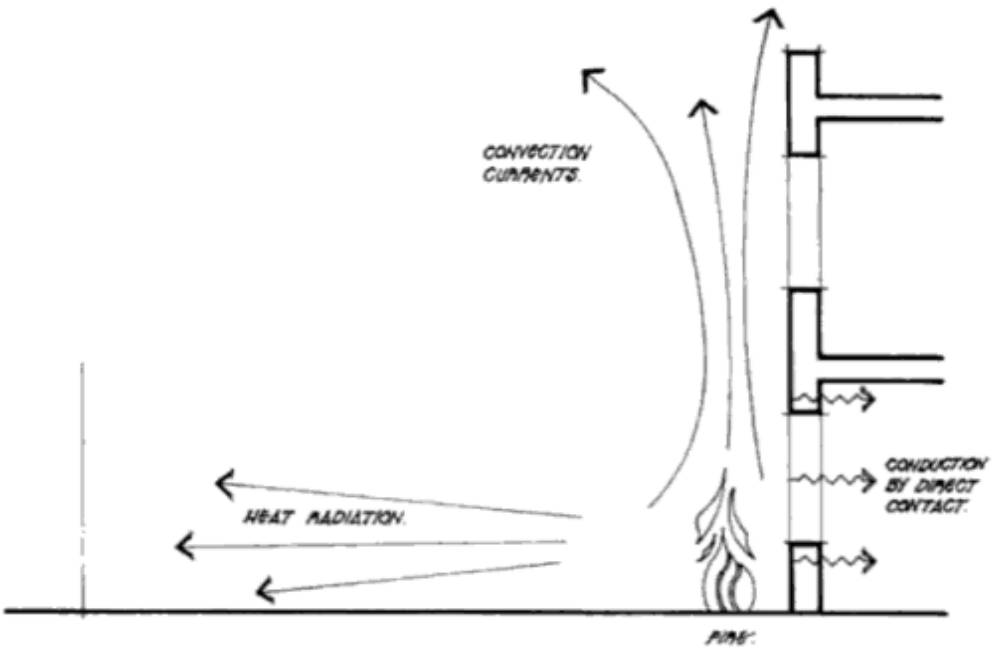

Fig. 1 - Forms of heat transfer [9]

2.3 By-Laws Requirement in Means of Escape (MoE) Design Criteria Compliance with the (MoE) Design Requirements in Government Hospital Buildings will be based from the Following Enlisted by-laws

Table 1 summarise the requirement of means of escape design criteria as indicated in the Uniform Building by Law (UBBL).

Table 1 - The Requirement in Means of Escape (MoE) by UBBL

1.0	Exits (Openings)	
1.1	Accessibility of exits.	UBBL166/2
1.2	Availability of 2 separate exits in every storey.	UBBL166/1, UBBL167/1
1.3	Ability of exits to give direct exit to final exit, a protected staircase leading to final exit, or an external route leading to final exit.	UBBL174/2
1.4	Location of exit not close than 4.5m from each other.	UBBL167/1, UBBL174/1
1.5	Not less than two exits are remotely located to each other shall be provided on each floor or fire section of a building.	NFPA101/20.2.4.2
2.0	Escape routes (Egress/corridor)	
2.1	Escape route free from obstruction and not use for storage.	-
2.2	Escape route maintains at same width along their length of travel.	UBBL169
2.3	When the communicating space includes an open stair, the opening created between floors shall be a minimum of 50 percent larger than the footprint of the stair and any landings.	NFPA101/8.6.6(C)
2.4	Egress capacity is sufficient to allow all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single floor area in determining the required egress capacity.	NFPA101/8.6.6(8)
2.5	Each occupant within the communicating space has access to not less than one exit without i) having to traverse another story within the communicating space, and ii) having to enter the communicating space.	NFPA101/8.6.6(9&10)
2.6	The clear width of any corridor/passageway required for exit access shall be not less than 1120mm.	NFPA101/21.2.3.3
2.7	Dead end corridor shall be permitted if i) if there's supervised automatic sprinkler, the dead-end corridor shall not exceed 15m or, ii) if there's no sprinkler, dead end corridor shall not exceed 6100mm.	NFPA101/20.2.5.2
3.0	Evacuation	
3.1	Availability of evacuation plan.	-
3.2	Successful rate of occupants evacuates during fire drill.	-
4.0	Travel distance	
4.1	Travel distance to all exits must not more than 45m.	UBBL165, UBBL166/2
4.2	Maximum travel distance of 15m is permitted if there's availability of sprinkler system when the travel distance to any exits exceed 46m.	NFPA101/21.2.6.2.2
4.3	Travel distance for place of assembly from any point to reach an exit not exceed 45m.	UBBL188
4.4	Compliance of the travel distance to the maximum distance calculated in accordance with provision in the Seventh Schedule.	UBBL165
5.0	Exit door	
5.1	Determination whether all exit doors are openable from the inside without the use of a key or any special knowledge or effort.	UBBL173/1
5.2	Determination whether all exit doors able to close automatically when released and all door devices including magnetic door holders able to release the doors upon power failure or actuation of the fire alarm.	UBBL173/2
5.3	Determination whether all doors used by the public as exit door from any part of the place of assembly or leading to the open air	UBBL186/1

	only open in the direction of exit.	
5.4	Determination whether all exit doors and doors through which the public pass on the way to the open air are without lock, bolts or other fastenings while the public are in the building.	UBBL186/2
5.5	Doors in stair enclosure are held open by an automatic release device.	NFPA101/20.2.2.3
6.0	Exit capacity	
6.1	Calculation of storey exit width.	UBBL176
6.2	Calculation of occupancy load and capacity of exit.	UBBL175
7.0	Fire-fighting staircase	
7.1	Availability of mean of egress via at least 2 separate staircases.	UBBL168/1, UBBL229/1
7.2	Compliance of the width of staircase to the width calculated in accordance with provision in the Seventh Schedule.	UBBL168/2
7.3	Availability of protected lobby to serve staircase.	UBBL197/1
7.4	Determination whether the enclosed staircase come with ventilation at each floor or landing level by either permanent openings or openable windows to the open air having a free area of not less than $1m^2$/floor.	UBBL198/1
7.5	Determination whether the enclosed staircase below ground level equipped with suitable means to prevent the ingress of smoke.	UBBL201
7.6	Determination whether the staircase provided has direct access to fire-fighting lobby.	UBBL229/4
7.7	Computation of number of staircase and staircase width.	UBBL177
8.0	Place of assembly	
8.1	Determination whether the exit for place of assembly is located, separated or protected to avoid any undue danger to the occupants of the place of assembly from fire originating in the other occupancy smoke therefrom.	UBBL178
8.2	Identification of the classification of places of assembly.	UBBL179, UBBL183
8.3	Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of the open stairs and ramps discharging through the street floor.	NFPA101/20.2.3.2
9.0	Vehicular access considerations	
9.1	Significance of design consideration for vehicular access.	GTFPM2006 4.2.2
9.2	6m access must be provided if building has volume >112,000m^3	GTFPM2006 4.2.2
9.3	If it is an island building, the road for fire access should be 12m wide	GTFPM2006 4.2.2
9.4	The building must have accessible 6m back lane	GTFPM2006 4.2.2

2.4 List of Fire Accidents in Government Hospitals in Malaysia

Fire accident has happened in Malaysia from time to time. Table 2 below summarise the fire accidents that happened in government hospital building in Malaysia from year 1993 to the recent event.

Table 2 - List of Fire Accidents in Government Hospitals in Malaysia

Hospital Name	Death	Date
A fire at Neurology Institute, Kuala Lumpur Hospital.		July 8, 1993
Staircase on third floor of University Hospital Kuala Lumpur caught fire.	-	July 16, 1995
Power supply tripping in an elevator caused fire on first floor of Neurology Institute, Kuala Lumpur Hospital.	-	May 2, 2007
A fire in store room at the South ICU ward, Sultanah Aminah Hospital, Johor Bahru.	-	July 30, 2008

A small fire at the electrical wiring at the South ICU ward, Sultanah Aminah Hospital, Johor Bahru.	-	January, 2010
Fire occurred in Mental Patient's Isolation room at Kuala Lumpur Hospital's emergency department.	1 death (patient)	July 30, 2011
A small fire at Centralise Air Handling Unit (CAHU) room at the Komplek Pakar dan Rawatan Harian, Kuala Lumpur Hospital.	-	February 6, 2014
A block of a new building at Sarawak General Hospital caught fire.	1 death (construction worker)	Feb 15, 2014
A fire in the ward was empty at Tuanku Jaafar Hospital, Seremban	-	May 16, 2015
A small fire at the switch oxygen pipeline and socket outlet in the ward at Level 7, Tengku Ampuan Rahimah Hospital, Klang.	-	May 27, 2015
A small fire at the air conditioning system near bed No. 26 in the South ICU ward, Sultanah Aminah Hospital, Johor Bahru.	-	May 5, 2016
A fire in store room at Sri Kota Hospital, Klang .	-	August 15, 2016
A small fire at the switch socket outlet near bed No. 31 in the South ICU ward, Sultanah Aminah Hospital, Johor Bahru.	-	October 14, 2016
A fire broke out at the storage room of South ICU ward, Sultanah Aminah Hospital, Johor Bahru.	6 death (patients)	October 25, 2016
Faulty wiring (in a cubicle or dividing wall between the beds) causes a small fire in the ward 5B, Raja Permaisuri Bainun Hospital, Ipoh.	-	November 9, 2016
A small fire at the NICU ward, Shah Alam Hospital.	-	February 15, 2017
A fire broke out at the Linen room of 3 & 4 wards, Segamat Hospital.	-	March 25, 2017
Short circuit causes a small fire in the ward 23, Sibu Hospital.	-	November 17, 2017
A fire broke out at the disposable items storage room in the Institute Perubatan Forensik Negara (IPFN), Kuala Lumpur Hospital.	-	March 17, 2018
A fire broke out at Female ward, Sultanah Aminah Hospital , Johor Bahru.	-	June 28, 2020

Among the list of fire accidents, the fire accident that happened at the Intensive Care Unit (ICU) on the second floor of the Sultanah Aminah Hospital in Johor Bahru dated 25 October 2016 shocked the public regarding fire safety issue of Government hospital buildings. In this accident, six patients were killed, and 11 people were injured and it triggered evacuation activity of hundreds of others. From the accidents that happen recently, Former Health Minister Datuk Seri Dr S Subramaniam said that most of the government hospital need to be audit [10] this is because most of the fire accidents involving government hospital is the old hospital that has been built before the existing of regulation as stated by State Health and Environment Committee chairman Datuk Ayub Rahmat, the hospital was built in 1930s and there was no requirement for the certification as the Fire Services Act 1988 is only exist and required for the building that is built after 1988 [10]. It is important to learn from this case because it Our Government is still developing the latest set of rules and standards to ensure that the quality of fire safety in Government hospital buildings

is in line with the one in developed countries which can provide valuable lessons and experiences to prevent a similar mistake from being repeated.

3. Methodology

To achieve to aim and objective of this research paper, the researcher will start with a literature survey to develop a strong understanding about the cases occurred at the hospital building. We focus mainly on other countries cases and try to produce a solution for government hospitals in Malaysia. Since a hospital is responsible for the patients' life protection, it should be graded as such that when fire occurs in the building [11]. It can cause a significant and real cost to the society. Therefore, with this kind of financial constraints, hospital must be constructed functionally and economically. Researcher will explain about the cases occurred in the other country. Online study about the cases been done. Then, recommendation and suggestion for a better safety system in term of means of escape will be given for hospitals in Malaysia. Means of escape is divided into many elements and in this paper researcher had suggested recommendation in every element and generally researcher has recommended for a better fire sprinkler system. It is considered as the best solution because it can cut cost and can increase the productivity of the fire system as well.

3.1 Case Study

3.1.1 US Fire Incident

Until the early 1970s, In the United States of America, there have been a number of significant hospital fires. The following are the most important events:

- Cleveland Clinic Hospital (1929) - fire and smoke was transported via ventilation shaft and open staircase, and it spread to other areas of the building, resulting in 125 deaths
- St Anthony's Hospital, Effingham, Illinois (1949) - 74 people died as a result of a fire that spread through garbage cans, laundry, floors, walls, and a stairwell.
- Mercy Hospital, Davenport, Illinois (1950) - 41 people have died in a treatment hospital in which the exit is shut..
- Hartford Hospital, Connecticut (1961) - 16 people died as a result of a fire that spread from the basement to the 9th floor through a vertical trash chute. Then, with the aid of flammable ceiling tiles, it rolled around the board.
- Sac-Osage Hospital, Missouri (1974) - After the flash in the ward, eight people died in one-story hospital wings. The patient began entering the next room because the door was not closed. One patient died as a result of a lack of oxygen.

3.1.2 UK Fire Incident

In the United Kingdom, there have been a fair number of fires. Five major hospital fires were registered in London in 2008-2009, according to the National Health Service [8]. It's not uncommon to have so many fires in a single year, but none have resulted in injury or death. Here's a brief breakdown of what has been going on:

- Royal Marsden Hospital - A fire broke out in the new rooftop room that day, necessitating a 4-minute logging into the Critical Care Unit, which is situated directly below the rooftop. People in this area are being displaced horizontally in order to create a community. All of the building's occupants were evacuated and a "ski pad" was used to support the mattress to allow for vertical clearance. Since negotiating the revolving door at the hospital entrance was difficult, they were pushed vertically out of the house.
- University College Hospital - The fire started in the middle of the night. This structure is connected to the structure next to the underground tunnel. The fire started in the basement, but its effects could be seen in the adjacent house. Indoors, fire has an effect on oxygen and compressed air supplies. Since no patients were inside the building at the time of the fire, no transfers were made.
- Osmond St General Hospital - At 8:20 a.m., a fire broke out in the 5-story building. The smoke waggons quickly spread to neighbouring wards. Within 28 minutes, a total of 23 children were transmitted horizontally. The majority of these kids have droplets. The heart patient was temporarily relocated to an adjacent building. Because of the simultaneous use of radio and cell phones during the evacuation, there is some misunderstanding.
- Chase Farm Hospital (psychiatry) - • A huge fire broke out on the roof. The patient is first pushed horizontally, then outward. In the house, there are two levels. At 6:35 p.m., the building caught fire.
- Northwick Park Hospital - A ten-story house. This structure is connected to a horizontal corridor and is situated next to St Marks Hospital. The fire broke out at 2:35 p.m. in an electric plant room under one hospital wing, and people were evacuated using the partial transfer process. A vertical servlet is causing smoke to disperse. A total of 128 people are being moved or shifted in different ways. The patient's vertical movement in bed is very clear. 1difficult due to a shortage of resources (sheets) and inadequate preparation. It takes about 23 minutes to clear the area.

4. Research Findings and Discussion

4.1 Key Principles for Design

4.1.1 Importance of Fire Engineering

Despite the fact that the design adheres to all of the Building Code Australia - Volume One and DHHS Capital Development Mandatory Requirements Guidelines - Series 7 Fire Risk Management, Guideline 7.6 is deemed as achieving the relevant Performance Requirements from a regulatory and DHHS point of view, it is simplistic to assume that the Building Code of Australia - given that many of the prescriptive measures tend to be somewhat subjective and were written to cover a wide range of building circumstances within each Class of building, Volume One prescriptive measures are often suitable for modern buildings. Prescriptive measures prescribed by the Australian Building Code - Volume One may be insufficient in some situations, while others may be too costly and provide little to no protection. On the one hand, when reviewing a building's fire engineering or fire risk assessment, prescriptive criteria should be overlooked. If the following happened, fire engineering assessments will be most successful:

- fire safety engineers have early involvement in the project
- Engineers provide advice to clients independently of advice from a building surveyor. The project should require the participation of a building surveyor.
- Engineers have the knowledge and awareness of the literature incidents in the past and fire safety history. This is a part of the publication's goal.
- Engineers have a thorough understanding of building structure and details as they pertain to the hazards of a building fire, for example::
    - Possible types of equipment and content in a particular space and potential cause of ignition and flammable quantity
    - How different services including electricity, air conditioning, and gas are distributed across the house, from supply to distribution and home understand the proposed architecture and where possibly can be used
    - Determine all possible pathways for smoke and fire to pass into the cavity.
    - Difficult to classify "sensitive" areas inside the building where the transition occurs

- Fire safety engineers are accredited by DHHS and have as many requirements as possible competency in design and engineering of fire and fire risk assessment tasks involved.

4.1.2 The risk perspective (Fire Services Department, 1998)

When considering the relevance of fire hazards in relation to the proposed design, the risk perspective motivates a planner to ask the following questions:

- What are the possible consequences?
- What are the chances of anything like this happening?
- What would it take to "mobilise" a threat and ignite a fire?
- What are the most important methods of prevention and mitigation?

The word "risk level" refers to a combination of factors that are normally associated with a product of probable cause and as a consequence, it's important to note that both elements are key. It's worth noting that a probability of 0.1 with a consequence of 1 has the same risk level as a probability of 0.01 with a consequence of 10. However, high-consequence events elicit far more societal and political intolerance than low-consequence events, particularly in buildings such as hospitals. As a result, a "tolerant" risk level may be agreed for events with higher consequences than events with lower consequences that occur more frequently. In practice, the level of risk accepted is rarely defined, but the methodology of risk can be used to think about the above systematically. Depending on the circumstances, some risk reduction strategies may be less successful than others. Engineering knowledge is important to determine if this is happening and what steps are most effective in reducing the level of risk.

4.2 Hospital Building Operating Aspects

As mentioned earlier in this guide, the logistics of transportation of patients, personnel, food, lines, supplies, and medical equipment, as well as other procedures, are critical for the proper functioning of hospitals. Simultaneously, very expensive medical or surgical instruments, other patient areas, or the workforce can be concentrated in those areas. As a result, it is crucial for all designers, especially fire safety designers, to understand the physical and operational characteristics of hospitals and related facilities from a fire safety standpoint. It is also essential for all designers to identify and comprehend the various hazards and threats that patients and hospital personnel face as a result of various hospital room functions. Another significant point is that designers are mindful of the essential and interdependent nature of the relationships between various patient and non-patient areas.

4.2.1 Physical Aspects

The following sections identify a variety of the physical and functional areas contained in hospitals, which can be found in large, complex structures. To ensure that a comprehensive fire protection design plan is developed, it is essential that fire safety and other designers recognise the roles of each of these areas as well as the fire hazards found within.

4.2.2 Parking and Load Dock

These are normally at the bottom of the building, but they are linked to the ground by elevators and stairs, allowing direct access to the public and possibly reception areas on a higher level. The nature of this relationship is through the elevators and stairs between the parking lot and the entire hospital should consider the possibility of fire in it parking and major gaps around elevator doors and landing doors restrict the amount of smoke that can be transported by a given elevator shaft. Using the elevator lobby at the parking level, as well as sufficient ventilation / mechanical ventilation in the parking lot, may be a solution to this issue. Loading docks are infamous for carrying high fire from the parking lot, as trucks and vans transport and remove vast volumes of inventory, posing major fire risks. These areas need a high level of fire safety, as well as smoke and fire loading docks from other parts of the hospital.

4.2.3 Storage Area

The hospital storage area may be a specialised cage or part of a larger room that includes a kitchen, patient care area, road access, or an operating theatre. Many modern hospitals are following the trend of reducing on-site storage and relying on smaller shipments from suppliers. There are numerous specialty shops in the hospital. A 3m x 4m storage space is typical. Despite the fact that storage areas are typically uninhabitable, fires often occur at great heights. It's important to think about whether or not these stores need to be designed in a fire-resistant manner.

4.2.4 Patient Treatment Area

Locality Patient care areas are divided into wards and recovery areas, according to the Building Code of Australia - Volume One. The first section is for patients who may be able to live and includes bedding, food, and treatment, while the second section is for patients who may not be able to live for the time being. Extensive Radiology facilities such as X-Ray, CT, Fluoroscopy, MRI, and nuclear medicine are available in the Operation Stage, Preparatory Area, and Recovery Area. Here, the area is relatively safe and only accessible to authorized personnel or patients staff care. Intentional fire is unlikely and should not be considered further. However, fires may occur for a variety of causes, including electrical or equipment failure, as well as human error. Since the equipment in some areas of this treatment is costly and in high demand, the safety of patients and personnel in this field is not only critical, but area security to provide equipment protection and reduce process disruption may also be a major concern.

4.2.5 Area of Preparation and Recovery

Since the equipment in some areas of this treatment is costly and in high demand, the safety of patients and personnel in this field is not only critical, but area security to provide equipment protection and reduce process disruption may also be a major concern. The curtains are typically made of polyester cotton blends and are fireproof. There is some additional furniture, and the staff in this area is nice. The recovery and planning areas include offices with clear patient visibility and a fire hazard that resembles an open office layout more or less.

4.2.6 General entrance, emergency, shop and general reception

This may be considered same to office retail and not light medicine environment. The Building Code of Australia - Provision of Volume One DtS allows fireplaces up to 5000m2 (retail assumption) to be very large and bear a reasonably high fire load. Keep in mind that Department of Health (2015) recommends a maximum 2000m2 square footage in healthcare building. These areas can accommodate large number of peoples, especially during peak hospital hours.

5. Recommendation and Conclusion

Table 3 summarise the recommendation in terms of elements of means of escape.

Table 3 - The elements of means of escape, its definition and recommendation

ELEMENTS	DEFINITION	RECOMMENDATION
Exits (Openings)	Any exit discharge openings that lead directly outside or to a street, walkway, refuge place, public way, or	Increase the number of openings available, so that it will easier fr the building occupants to escape out from the building during fire.

	open space with direct access to the outside.	
Escape Routes	The planned route which building occupants may use to reach a place of safety from any dangerous incident.	Make a well planned plan and paste it everywhere needed and can be easily seen by the by the building occupant itself.
Evacuation	Act or process of evacuating people from a certain place.	Need to be done very fast and need to have a person in charge during the emergency. Need to assign an evacuation coordinator to make the evacuation flow much easier
Travel Distance	The distance between a specified point in a building from a place of safety, in the event of a fire. The distance of buildings' exits and place of assembly	The travel distance must be maximum 45 metres. If the present travel distance doesn't meet the minimum requirement, it should be reconstructed to obey the UBBL.
Exit Doors	The accessible door is used to escape the building during the fire incident.	The exit door must be always accessible and open, so that the building occupants can evacuate much easier during the fire.
Exit Capacity	The capacity of building occupants that able to escape safely at one time during the evacuation process.	Exit width must be suitable with the loads of the building, if it doesn't meet the minimum requirement set by UBBL it need to be reconstructed.
Fire-Fighting Staircase	Protected enclosure provided for attending fire-fighters and escapees which can be accessible during a fire incident.	Availability of mean of egress via at least 2 separate staircases. Big buildings need to have more than one fire staircase, to make sure the building occupants can evacuate themselves safely
Place of Assembly	Separated place/area allocated for the gathering of people for safety.	Place of assembly is one of the important place, it need to be very near so that the building occupant can reach very fast before the fire start to spread very fast

Additionally, based on the online study that had been done, there are recommendations will be given to improve the building safety system in terms of means of escape. Basically, when a building is on fire, the main thing that the building occupants will rely on is the building's fire sprinkler. Based on the previous cases occurred at US and UK, they strongly recommend a better design of fire sprinkler. As what stated by Woon Chin Ong and Mohd Zailan Suleiman [13], hospitals in Malaysia, the design is not following the fire requirement and a lot of equipment used is outdated. To decrease our cost and increase our productivity of fire system, researcher recommend a better design of fire sprinkler. The sprinkler system's efficiency and efficacy are two aspects that a fire safety officer should consider. This is a design feature that will improve the building's protection. It is much more effective to restore a building with a new design. As far as effectiveness goes, designers need to make sure that the designated sprinkler system is compatible with any hazards and architectures features that can introduce significant protection. Sprinkler reliability is greatly influenced by the frequency of system isolation. Building work and maintenance may necessitate system isolation, which may result in future problems with underwater pipe erosion, which can also cause issues, particularly if the system was forced to work offline. This is something that should be considered during the design process, but for the time being, the researcher suggests having a sprinkler with a complete and perfect design. From a design standpoint, the system should be built in such a way that:

a) Portions of the system should be able to be separated without impacting the rest of the system whenever possible. Then, in addition to the smoke and fire compartments, there should be enough controlled subsidiary valves.
b) The building should be supplied with water from a high-reliability source, so that upgrades to the on-site supply and supply to the site would keep the system operational.
c) The fire sprinkler must be located fully at the high-risk area and even that area is small, that area must be equipped with the fire sprinkler as well.
d) It must be maintained well, and need to change the damaged part if there are so, immediately, to sustain the main objective which is protect the hospital building.

There are many complex problems associated with the design of hospitals, one of which is fire protection. Fire protection engineers and other designers must have a detailed understanding of how hospitals operate, the logistics

involved, and the specialised nature of certain parts of hospital buildings and their fire hazards. What researcher tried to conclude is, the cases occurred at UK and US hospitals are mainly because of fire accidents. And they came with a solution and they managed to decrease the fire cases there. According to Woon Chin Ong and Mohd Zailan Suleiman's studies on problems in the implementation of fire protection management in Malaysian government hospitals and fire safety management problems in hospital building fires [13]. The hospitals were found to have issues with fire safety management, such as paperwork issues, combustible materials, and the lack of installation of fire alarms or obsolete fire safety equipment, closed doors for security purposes, a lack of hospital personnel training, and fire safety systems being blocked. The number of cases can be minimized, and if the building catches fire, the fire sprinkler system can put out the flames [13].

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