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Research Article

CHALLENGES ON ESCAPE ROUTE DESIGNS IN HIGH-RISE HOSPITAL BUILDINGS IN TANZANIA

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Abstract

Patient safety is a high priority for the healthcare system worldwide. It is considered an indicator of the quality of care in any hospital building. This research assesses challenges in escape route designs in high-rise hospital buildings in Tanzania. Data were collected using the established questionnaire. The study population was 184 participants from five hospitals in Tanzania namely Muhimbili National Hospital, Agha khan Hospital, Kairuki Hospital, Rabinsia Hospital, and Temeke Hospital. Data were analyzed with Descriptive statistics and Principle component Analysis using SPSS. All of the ten domains of escape routes such as the presence of exit routes, enough staircases, and stairwells, clear directions to exit routes, presence of blockage in exit routes, locked exits, exit routes familiarity, presence of photo luminescent signs, presence of wide exit, visible exit signs and presence of smoke in stairways were established from theoretical knowledge to determine the challenges facing escape routes in high rise hospital buildings. Using the SPSS, the factor analysis through Principal Component Analysis (PCA) was conducted to determine the lesser number of factors or components which establish a dimension solution for the research. Bartlett's Test of Sphericity values shows that the variables are significantly correlated since the p-value is less than 0.05. Several factors with an Eigenvalue large than on (e>1), having four components solution model which explained the total variance of 58.24% were retained. Three variables namely the absence of wide exits, few staircases and stairwells, and stairways with smoke scored a high score of variance which indicate to have maximum effects on high-rise hospital buildings. Therefore, it is strongly recommended to maximize the size of exits, increase the number of staircases and stairwells, and other vertical circulation, and ensure exits are protected from smoke for effective escape routes performance.

Keywords: Patient safety, Escape routes, High-rise hospital buildings, Building evacuation, Fire safety.

INTRODUCTION

The Tanzanian building industry is developing and expanding every day. The number of high-rise buildings is rising progressively. The high-rise buildings in a country not only solve the problem of land use but also solves the congestion problems facing many low-rise buildings (Ibrahim, 2007). High-rise building occupants on upper floors may have a greater view of the neighborhood, and because they are higher up and away from the ground, there will be less street noise, which will boost their level of comfort and productivity. Unfortunately, high-rise buildings contribute to challenges and problems at the same time. One of the biggest challenges is evacuation during emergencies such as fires (Koo *et al.,* 2013). In 2014 through 2018, local fire departments in the US responded to an estimated average of 13,400 fires per year in buildings with heights of at least seven stories above grade. These fires caused an average of 39 civilian deaths, 464 civilian injuries, and $204 million in direct property damage annually. These high-rise fires accounted for 3 percent of reported structure fires, 1 percent of civilian deaths, 4 percent of civilian injuries, and 2 percent of the direct property damage associated with structure fires (Ahrens, 2021).

Fire spread beyond the room of origin in only 4% of health care fires. Fires in nursing homes accounted for a disproportionately higher share of civilian injuries, but a smaller share of direct property damage, relative to other health care facilities (NFPA, 2017).

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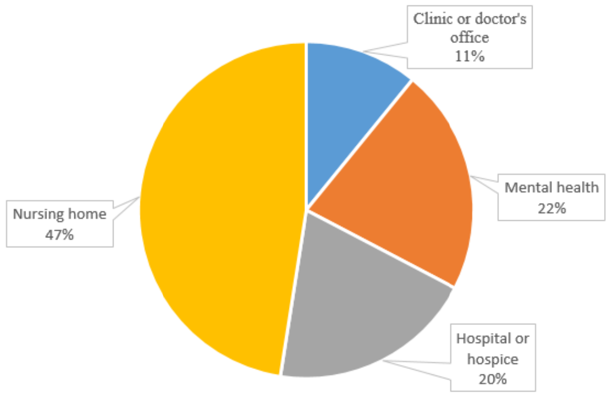


Source: NFPA, 2017

Figure 1. Structure Fires in Health Care Properties by Occupancy Type: 2011–2015

The leading causes and circumstances of fires in health care facilities showed some variation by specific health care occupancy. Cooking equipment was the leading cause of fires in all health care properties (66%). However, these fires accounted for just 3% of direct property damage, an indication that most are confined fires. Fires involving electrical distribution and lighting equipment and those with an intentional cause each accounted for 6% of fires, while heating equipment and smoking materials each accounted for 5% of the total. Fires caused by electrical distribution and lighting equipment accounted for 36% of direct property damage. Playing with a heat source caused 2% of fires (NFPA, 2017). Although the number of fire-related deaths has decreased by 42% since 1980, 2021 marks a 33% increase from the record low number of deaths recorded by NFPA in 2012 (2,855). The 2021 civilian fire death toll of 3,800 is 8.6% higher than the 3,500 total in 2020. The graph below shows the vast majority of these deaths resulted from home fires (NSC, 2022).

Table 1. Annual averages of High Rise Fires by occupants for 2014-2018

Occupancy	Fires		Civilian death		Civilian injuries		Direct Property Damage	
	Number	%	Number	%	Number	%	(Millions $)	%
Apartment or other multi-family housing	8580	64%	29	75%	368	79%	118	58%
Hotel	530	4%	0	1%	14	3%	10	5%
Dormitory-type property	470	3%	0	1%	9	2%	0	0%
Office building	230	2%	0	0%	4	1%	0	4%
Hospital, hospice, or nursing home	280	2%	0	0%	12	3%	1	0%
Subtotal	10,070	75%	30	77%	407	88%	137	67%
All other occupancies	3,330	25%	9	23%	57	12%	67	33%
Total	13,4	100%	39	100%	464	100%	204	100%

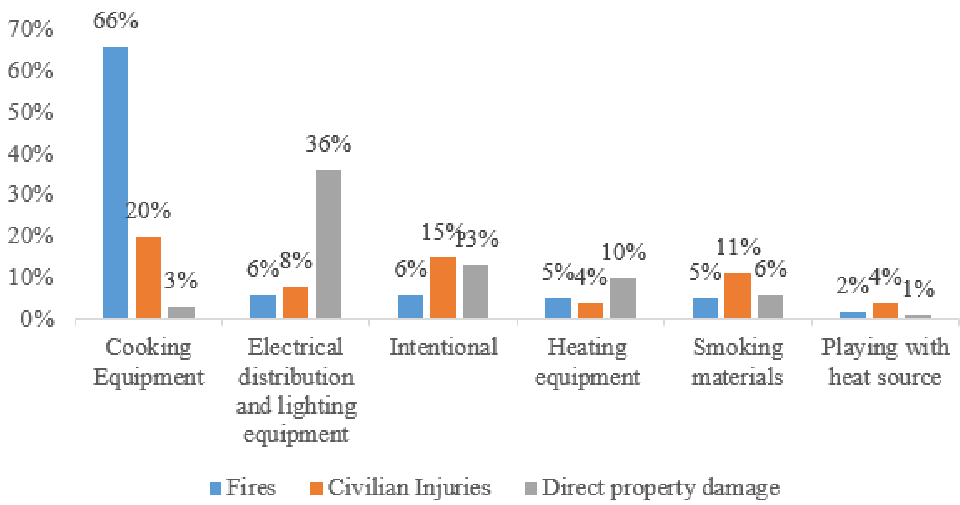
Source: NFPA, 2017

Table 2. Risk of Fire Casualty per Thousand reported Fires and Average Loss per Fire 2014-2018 Annual Averages

Occupancy	High Rise Buildings			Non High Rise Buildings		
	Civilian death per 1000 Fires	Civilian injuries per1000 Fires	Average loss per Fire ($)	Civilian death per 1000 Fires	Civilian injuries per1000 Fires	Average loss per Fire ($)
Apartment or other multi-family housing	3.4	42.9	13,700	3.7	34.4	13,900
Hotel	0.7	26.6	19,800	3.1	35.3	25,600
Dormitory-type property	0.7	19.8	1,000	0.2	7.3	5,300
Office building	0.0	18.0	35,300	0.4	11.8	24,500
Hospital, hospice, or nursing home	0.0	43.5	2,800	0.6	24.1	5,400
Average of five occupancy group	3.0	40.4	13,600	3.6	37.9	14,000

Source: NFPA, 2017

Table 3. Leading causes of Fires in health care facilities 2011-2015 Annual Averages



Source: NFPA, 2017

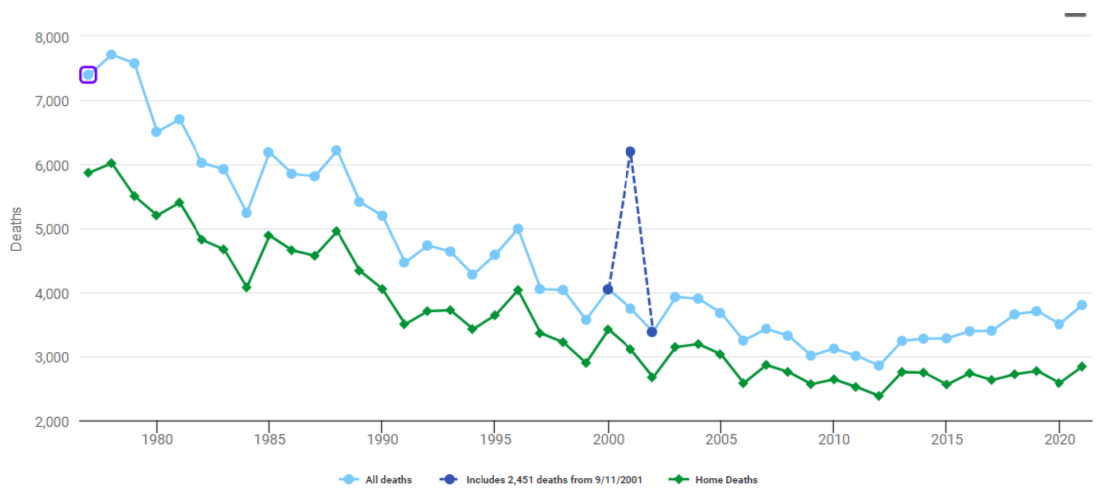


Figure 2. Total civilian fire deaths and home fire deaths, United States 1977-2021(Source;US National Safety Council)

According to the latest WHO data published in 2020 Fires Deaths in Tanzania reached 1,424 or 0.48% of total deaths. The age adjusted Death Rate is 2.84 per 100,000 of population ranks Tanzania in number 53 in the world (WHR, 2022). There are positive impacts of fire in our daily lives (Scott *et al.,* 2016). However, the fire could cause negative consequences such as damage and injuries (Koo *et al.,* 2013). Fire may cause fatal and severe injuries to the users of the buildings and at the same time direct damage to the buildings. This will lead to consequential losses for building occupants (Billington *et al.,* 2002). Even so, in the case of hospital buildings, fire can be a very disastrous event (Abhishek, Shastri *et al.,* 2018). This is because the hospital occupies different types of people but most patients, are weak, and handicapped and they cannot evacuate themselves, their caregivers, nurses, and staff (Joshi, 2020; Sharma, Bakshi and Banerjee, 2020). Building fires are strongly related to our daily hospital activities because flames can occur anytime, anywhere. (Philpott and Brompton, 2009). Sometimes patients and staffs are incapable to reach the ground floor level in time due to long traveling distances from the top floors. A large number of patients and staff may merge at some connections which may cause blocking, and delay the whole progress of evacuation from the building. Also, heavy heat and smoke exposure may cause exhaustion or death. (Billington *et al.,* 2002; Ramachandran, 1999). In that case, the safe escape from high-rise hospital buildings becomes difficult with or without help from the nurses. In ensuring safe evacuation, it is essential to guarantee that the escape routes are present, flexible, and safe for evacuation (Spear, 2005). However, every industry has a human element but designing escape routes in hospitals and understanding that connection is the heart of medicine (Şimşek and Akinciturk, 2015). With all the new medicines and advancing technologies in hospitals, it means nothing if escape routes are not functioning well during the fire and vulnerability period. Despite this, the escape routes must be planned at the user profile by providing escape lengths in accordance with the safety laws and regulations to guarantee the safe evacuation of patients and personnel from a fire to a safe region in the shortest amount of time. The designers need to be careful because the process of evacuating people in hospitals is comparatively slower and more challenging than from other buildings. Hospitals require special solutions because they are in exceptional circumstances since they have patients with inadequate movement capability (Hashemi, 2018).

Objective of the research

Although hospitals in Tanzania are planned and designed with consideration of escape routes, most of them are not patient and workers friendly and can either be difficult to access or never accessed during fire or danger. Most of these escape routes are not universally fit for purpose and responsive to the expected (and unexpected) disasters that may happen in hospitals, and they are unfit in terms of quality, and effectiveness (Braeseke, 2011). Fortunately, there are currently no economical ways to construct these escape routes, which would have an impact on overall building costs. Most of these escape routes lack settings that are flexible enough to adjust to any changes in needs and do not use readily available, inexpensive materials. This is especially important for hospital facilities that need to adjust to shifting community demographics.(Purser and Dave, 2001). Having said that, most high rise hospitals are not built with the requirements of the people who work there and the patients in mind. The majority of personnel are not happy with their environment, which also affects patient care. This research explores the challenges facing patients and staff in using escape routes in high-rise hospital buildings and recommend for future high-rise hospital building escape route designs in Tanzania.

LITERATURE REVIEW

Escape routes definition

Escape route can be described as the path that individuals can use to get from any location inside a building to the main exit (DETR, 2000). When creating a passive fire safety plan, a secure escape path ought to come first (Soja, 2017). The protection of the building's residents comes first in the context of fire safety. If the goal is to save lives, it must be made sure that people have the time and resources to flee in the event of a fire to a location where they would be completely secure. The "escape route" or "evacuation route," which is a horizontal safe path (corridors or rooms) or vertical safe path (stairs or, in some cases, elevator shafts) for individuals to walk from any area in the building or structure to a safe place without the need for outside aid, must be protected in order to do this. However, it has been noted that some of the escape routes in the majority of high-rise hospital structures do not guarantee a secure evacuation for personnel and clients who are at risk of fire. Firefighters who enter the structure to put out the fire or look for persons still may not be able to rescue victims quickly and effectively. Additionally, they are not permitted to direct workers to a building's final escape or to a shelter for refugees if an evacuation is not feasible. The risk of a fire is increased by the absence of certain preventive measures that must be put in place to establish a reliable escape path. Most high-rise buildings do not consider providing a fire-resisting products and systems around the escape route that can keep the fire out long enough for people to evacuate and the necessity of applying positive air pressure to an escape route to prevent smoke from entering in the event of a fire is poorly established. Products and systems should guarantee Integrity (E), insulation (I) and, in some cases, even radiation (W)), In most cases, a suitable escape route is characterized by three parts; First, it gives a harmless path of travel for people; second, the route itself is noticeable so that people will not get lost, even in low light circumstances; third, the route has been clarified to people in advance of a genuine emergency, so that they have an understanding with the path they should use in case of an emergency. Several elements, including as the kind and number of users of the facility, the escape time, the structure's age, and its architecture, must be taken into account for an effective assessment of the building's escape routes. On the other hand factors such as Time, escape route layout, utilization of stairs, elevators, and lifts; forms of evacuation; and emergency evacuation plans plays an important role (Kironji, 2015).

Concept of escape routes

The primary standard for the design of the escape routes is “The time available for escaping should exceed the time needed for escape” (Dehne and Kruse, 2007). According to literature, it takes far more time than we would anticipate for individuals to become aware of the fire, act, and evacuate. For this reason, the escape path should be able to withstand fire for a lot longer than is typically thought to be essential (Thomas and Lloydd, 2004).

Older or disabled people may require special consideration during evacuation since they will need extra care, extra time, or alternative exit options (Hashemi, 2018). Additionally, the security of the rescue teams or the fire department may be taken into account. They might be able to evacuate people, battle and put out the fire to save lives, and protect the structure in the safest manner possible. The degree of fire danger present on the site may determine the level of fire protection that should be provided for escape routes. In contrast to a huge multi-story building or a facility where there are people who cannot evacuate rapidly, such as hospitals, nursing homes, schools, and hotels, modest premises with a single storey may only require very simple measures to secure the escape routes. These intricate structures can call for a more complex escape route that has been well tested. The escape route may be kept clear of smoke and substances that can impair breathing because both the smoke and the heat from a fire may hinder a person's ability to flee.

Evacuation in High rise buildings

From the literature, the high-rise building can be explained from different perspectives. However, the National Fire Protection Association (NFPA, 2012) defines a high-rise building as one that is more than 75 feet (approximately 23 m) tall, measured from the ground level where a fire department vehicle can access it to the floor of the highest occupied story.The International Conference on Fire Safety in High-Rise Buildings, on the other hand, defines high-rise buildings as any structures whose height can significantly affect evacuation. Finding information from this perspective will be the main goal of this research. The entire evacuation time needed for residents to leave the building safely is crucial for high-rise buildings (Zhang, 2017). It is generally known that the building's height and the availability of an egress evacuation may decrease the risk of residents removing themselves in emergency evacuation situations. When employing the conventional mode of evacuation using just stairways, the vertical distance that an occupant, particularly those who are disabled and older persons, must travel may not be possible at certain heights. In such cases, the suggested egress system might need to be reevaluated to take other options into account (Kealy, 2008). There are numerous creative and inventive evacuation methods for high-rise buildings that have been explored and proposed by some individuals and certain groups, aside from the upgrading of current systems like fire stairs and elevators for the fire escape. For instance, Wood (2007) pointed out that Platform Rescue Systems (PRS), Controlled Descent Devices (CDD), and Escape Chutes as creative and inventive evacuation methods for high-rise buildings (Wood, 2007).

Escape routes in high-rise hospital buildings

It is thought that the rapid urbanization and population growth are directly related to the rise in the number of tall structures especially hospital buildings. A study conducted at the University of British Columbia in 2015, concluded that “larger cities have on average taller and bigger buildings as an adaptation to higher population and employment densities and levels of income” (Schläpfer and Bettencourt, 2015). However, there is a very high risk of fire events associated with this kind of property. High-rise hospital building fires frequently result in severe injuries to occupants, destruction of some property, and catastrophic loss of life and property due to type of occupants using the building. While putting out a fire to save lives and property is a conventional practice, in other cases the strategy may seem futile because some of the property has already burned, and worse, it poses a very high risk to the firefighters. As a result, the best way to reduce the danger of fire in high-rise buildings can be taken into account during the crucial conceptual design phase. During the conceptual design phase, it is advised that architects and engineers consider a plan that includes the necessary level of safety precautions in accordance with engineering and statutory requirements, including the installation of systems to mitigate against all potential sources of fire and then be continuously maintained (Sagun, Anumba and Bouchlaghem, 2013). However, the main issue is whether or not tall buildings' architectural design and fire safety design considerations are effective. It is not acceptable to see modern tall buildings in the future still relying on regular staircases for emergency exits (Kealy, 2008).

METHODOLOGY

Population

The analysis of the five high-rise hospitals gave a population the diversity, representation, accessibility, and information that is needed. The sample of hospitals in high-rise buildings that were already operational suited the goal of this study, saved time, simplified things, and removed biases and errors associated with sampling. The 5 high-rise hospitals were selected from all three Dar es Salaam districts, Ilala, Kinondoni, and Temeke.

Area of Study

Dar es Salaam city was chosen as the case study area for this research because it is seen to be a region with rich information and because whatever happens there has an impact and an influence on the entire country (Kironde, 2002). The data were obtained from various high-rise hospitals located in Dar es Salaam which have a huge number of users (patients, nurses, and doctors) which are Muhimbili National Hospital, Agha khan Hospital, Kairuki Hospital, Rabinsia Hospital, and Temeke Hospital.

Table 4. The number of floors and year of construction

Name of Hospital	Date of Construction	Number of floors	Location
Muhimbili National Hospital	1897	7	Malik Road
Agha khan Hospital	1964	7	Baraka Obama Road
Kairuki Hospital	1997	8	Chwaku street
Rabinsia Hospital	2014	9	Bagamoyo Road
Temeke Hospital	1972	4	Sungwi street

Sample size

The population size of the study came from hospital users based in high-rise hospitals in Dar es Salaam city, Tanzania. The target populations were hospital users (i.e patients, staff (nurses and doctors), and other users) of high-rise hospital buildings in selected high-rise hospitals in Dar es Salaam. The mode of selection of hospital buildings is based on the number of floors the hospital building has.

Sampling methods

The sample size formula for the small and finite population is provided by (Kothari, 2004) and is given as;

$$n = \frac{Z^2 \times N \times pq}{< N - 1 > e^2 + Z^2 \times pq}$$

Where;

Z=Z value from a table of confidence interval=CI=95%=1.96
N=Population size=184 respondents
p = Sample proportion=0.5, q=1-p = 0.5
e2=Margin error=5%=0.05

Therefore;

$$n = \frac{1.96^2 \times 184 \times 0.5^2}{< 184 - 1 > 0.05^2 + 1.96^2 \times 0.5^2}$$

$$n = \frac{176.7}{0.4575 + 0.9604}$$

$n = \frac{176.7}{1.4179}$ =125

n = 125 respondents

Five high-rise hospitals were the subjects of the methodological approach, which was a synthesis of quantitative and qualitative methodologies. The researcher used a pre-designed checklist to access the escape routes and record any shortcomings. Other methods of gathering data included document inspections, building managers, and user interviews. All five of Dar es Salaam's high-rise hospitals were listed in the random sampling process that was used to create the necessary sample. The total number of respondents who were projected to be given the questionnaire was as follows;

Table 5. Representation of the number of respondents per hospital

Name of Hospital	Patients	Staff	Others (Visitors)	Total
Muhimbili National Hospital	25	25	7	57
Agha khan Hospital	14	14	6	34
Kairuki Hospital	20	12	6	38
Rabinsia Hospital	14	13	6	33
Temeke Hospital	10	8	4	22
Total	83	72	29	
			Population	184
			Sample size	125

Convenience and snowball sampling methods were used to choose participants in the interviews. To get their perceptions, opinions, knowledge, and attitudes variables namely the presence of exit routes, enough staircases and stairwells, clear directions to exit routes, presence of blockage in exit routes, locked exits, exit routes familiarity, presence of photo luminescent signs, presence of wide exit, visible exit signs and presence of smoke in stairways were identified and 125 respondents were given a questionnaire to indicate their response. The below table indicates several factors that were considered the most challenging items. The abbreviations were used to simplify the analysis process using the SPSS.

Table 6. The collection of variables and their abbreviations

SN	Variables	Initials
•	Blocked exit routes	BER
•	Locked exits	LES
•	No wide exits	NWE
•	Exit routes interfered with construction projects	ECP
•	Exit routes not familiar	ERF
•	Unclear directions	UDS
•	No visible exit signs	NVS
•	Staircases and stairwells are not enough	SSE
•	Stairways with smoke	SWS
•	Absent photoluminescent signs.	APS

The replies were evaluated using a Likert scale, which includes the response options such as Agree/Yes and Disagree/No.

Data collection methods

The questionnaire was designed in such a way that it answers the objective of the research. The method of submission of the questionnaire was through the provision of hardcopy questionnaires; the complete questionnaire was submitted after communication with respondents. A total of (125) questionnaires were distributed using the purposive technique of non-probability sampling to study participants which involved patients (65), Staff (47), and other construction industry stakeholders (13). Four assistant researchers were involved in the data collection. The data collection process by this method was quite good. Out of the 125 copies of the questionnaire that were issued, 115 copies (92%) were returned. Table 4 below compares the distributed and received questionnaire to provide a summary of the data gathering procedure.

Table 7. Questionnaire responses

Number of questionnaires					
		Distributed	Returned	Percent	Percentage of success
Valid	Patient	65	61	53	93.8
	Staff	47	45	39.2	95.7
	Other Users	13	9	7.8	69.2
	Total	125	115	100.0	

Data analysis and Empirical findings

The study was conducted from specific observations through tentative hypothesis to broader generalization. Thereafter, the questionnaire survey method was used to present a full list covering all variables.

Table 8. Respondent accumulation

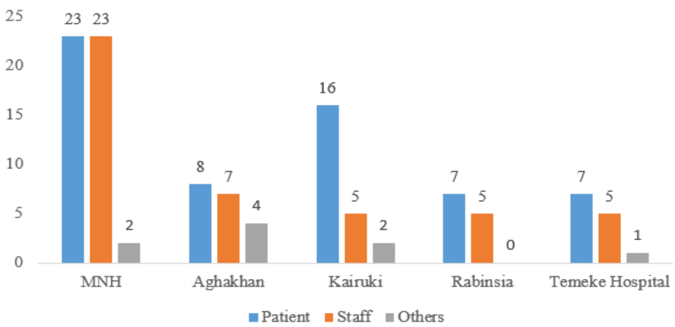
Title					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Patient	59	51.3	51.3	51.3
	Staff	44	38.3	38.3	89.6
	Other Users	12	10.4	10.4	100.0
	Total	115	100.0	100.0	

RESULTS AND DISCUSSION

After data screening, ten (10) questionnaires were not filled and hence neglected, hence only 115 questionnaires were used for data analysis. The responses from the data collected supported that; viability data for analysis should attain at least 20% of the respondent of the distributed questionnaire.

During data analysis, while frequency and percentage demonstrated the respondents' number, the mean portrayed the respondent's responses as per the questionnaire. SPSS was used to calculate the reliability and validity of data together with producing structural modeling that indicates the correlation between variables used.

Table 9. The respondent response size



Frequency and percentage were used to show the response distribution. From the data collected, the statistics indicate that more than 20 % are university graduates from different universities while 13% are diploma holders working within the industry for many years with tangible experience. Table 6 below shows the respondents' education levels.

Table 10. Respondent education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	2	1.7	1.7	1.7
	O level	19	16.5	16.5	18.3
	A level	28	24.3	24.3	42.6
	Certificate	28	24.3	24.3	67.0
	Diploma	15	13.0	13.0	80.0
	Degree	14	12.2	12.2	92.2
	Masters	9	7.8	7.8	100.0
	Total	115	100.0	100.0	

Using the SPSS analysis, the respondents responded to the major challenges of escape routes design in high-rise hospital buildings.56.5 percent of respondents believe that the presence of escape routes in hospital buildings strongly makes them feel safe while 60.9 percent of respondents believe that the presence of escape routes in buildings would make them feel. The responses are summarized in Table 7&8 below.

Table 11. Respondent summary

I believe the presence of escape routes will help the healing process					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree/Yes	65	56.5	56.5	56.5
	Disagree/No	50	43.5	43.5	100.0
	Total	115	100.0	100.0	

Table 12. Respondent summary

I believe the presence of an escape route in the hospital building would make me feel safe.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree/Yes	70	60.9	60.9	60.9
	Disagree/No	45	39.1	39.1	100.0
	Total	115	100.0	100.0	

To reduce a specific number of variables or items to a smaller number of factors or components (dimension solution) factor analysis utilizing Principal Component Analysis (PCA) was undertaken using SPSS analysis. Since the p-value is less than 0.05, Bartlett's Test of Sphericity results show that the variables are substantially correlated.

Table 13. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.596
Bartlett's Test of Sphericity	Approx. Chi-Square	118.848
	df	45
	Sig.	.000

On the other hand, since the criteria for selection of the number of factors to retain depend on when the Eigenvalue is large than on (e>1), then by using the table below four components were retained. These four explain 58.24% of the variance which is good (Most scholars accept>50%).

Table 14. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cum. %	Total	% of Variance	Cum. %
1	2.160	21.600	21.600	2.160	21.600	21.600
2	1.358	13.581	35.181	1.358	13.581	35.181
3	1.243	12.435	47.616	1.243	12.435	47.616
4	1.063	10.628	58.244	1.063	10.628	58.244
5	.950	9.502	67.746			
6	.871	8.706	76.453			
7	.786	7.862	84.315			
8	.657	6.573	90.888			
9	.511	5.114	96.002			
10	.400	3.998	100.000			

Extraction Method: Principal Component Analysis.

Also, a visual way of identifying the number of components is using a Scree plot. The X-axis (Eigenvalue) is plotted against the number of components on the Y-axis. The maximum number of components can be indicated from the Scree plot. Both Table above and the Scree plot below agree with the criteria of Eigenvalue being large than on (e>1) as they both indicate the four-dimension solutions.

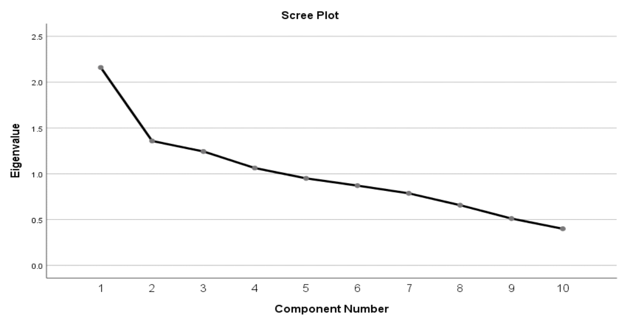


Figure 6. Graph of Eigenvalue against the component number

Table 15. Component Matrix

	Component			
	1	2	3	4
BER	.253	.323	-.399	.272
LES	.154	.732	-.036	-.152
NWE	.307	.106	.091	.832
ECP	-.048	.559	.539	-.206
ERF	.066	.503	-.236	.211
UDS	.664	.001	.044	-.192
NVS	.756	.007	-.240	-.231
SSE	.757	-.249	-.264	-.108
SWS	.446	-.245	.648	.260
APS	.431	.137	.424	-.131

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

From the table above, the values shown within the table show the strength of the association between the variables and the components. These values on variables which are Pearson correlation coefficient values are loading well when the values are more than 0.3 on components.

Table 16. PCA Communalities

Communalities		
	Initial	Extraction
BER	1.000	.402
LES	1.000	.584
NWE	1.000	.806
ECP	1.000	.647
ERF	1.000	.358
UDS	1.000	.480
NVS	1.000	.683
SSE	1.000	.717
SWS	1.000	.746
APS	1.000	.402
Extraction Method: Principal Component Analysis.		

From the table of communality table above, variables that show more effects from the variable list were obtained. The extraction values are variance values that indicate the effects of components on variables. No wide exits (NWE), Staircases and stairwells are not enough (SSE) and Stairways with smoke (SWS) have a high score of variance of 80.6%,71.7%, and 74.6% respectively which indicate have maximum effects on the high rise hospital buildings.

Conclusions and Recommendations

Patient safety in developing countries will face major challenges in the future. Some of them are often highlighted and considered concerning accessing the escape routes of high-rise buildings, especially in hospital buildings. This paper argues that there are challenges facing patients and staff on how to use the escape routes and that will bring considerably more challenges during evacuation to the refuge area, especially during a fire or any other catastrophe. The issue of fire safety is always considered noncritical in most third-world countries while the number of fire cases increases tremendously. It is necessary for more research and works to be done on the issues of fire safety in developing countries. This study has assessed the challenges of escape routes in the high-rise hospital building in Tanzania. A questionnaire was designed and disseminated among the three major categories of respondents (patients, staff, and others). Major challenges of escape routes design were identified namely (1) blocked exit routes (2) locked exits (3) no wide exits (4) exit routes interfered with construction projects (5) exit routes not familiar (6) unclear directions (7) no visible exit signs (8) staircases and stairwells are not enough (9) stairways with smoke and (10) absent photoluminescent signs. From the discussion above we can conclude that still maximum number of the escape routes in high-rise hospital buildings are facing big challenges for all users due to the lack of requirements identified by this research and therefore affects their effectiveness and performance. Three variables which are no wide exits (NWE), staircases and stairwells are not enough (SSE) and stairways with smoke (SWS) scored a high score of variance of 80.6%,71.7%, and 74.6% respectively which indicate to have maximum effect on the high rise hospital buildings. Therefore, it is strongly recommended to maximize the size of exits, increase the number of staircases and stairwells, and other vertical circulation, and ensure exits are protected from smoke for effective escape routes performance. Users (patients, staff, and others), construction practitioners (clients, contractors, and consultants), as well as academicians, can greatly benefit from the study's findings. The practitioners can work to lessen fire safety occurrences in high-rise hospital buildings by better understanding the dynamics of safety management.

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