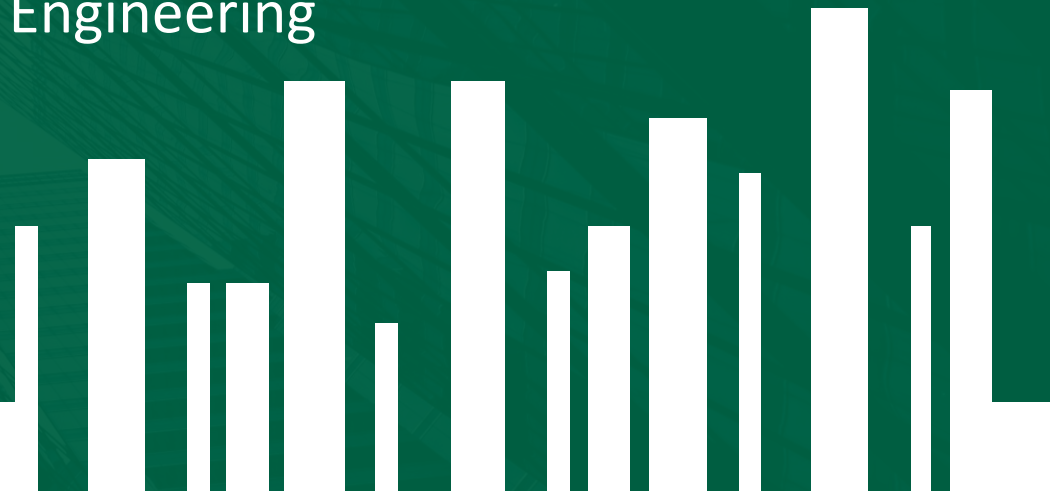


# Evacuation Strategies for People with Physical Disabilities in High-rise Buildings in Riyadh, Kingdom of Saudi Arabia.

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# Introduction

'HIGH-RISE BUILDING' is a building with an occupied floor located more than 23 metres above the lowest level of Civil Defence vehicle access (SBC,2018)

152 High rise buildings in Riyadh

(The report of the Riyadh Civil defense inspection campaign for high rise buildings in 2020)

About 4% of the population of the Kingdom of Saudi Arabia suffers from a mobility disability. 25.13% of the total Saudi population with disabilities are in Riyadh.

(Saudi General Authority for Statistics, Disabled Persons Survey, 2017)

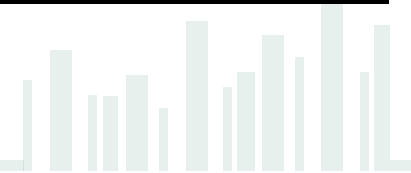
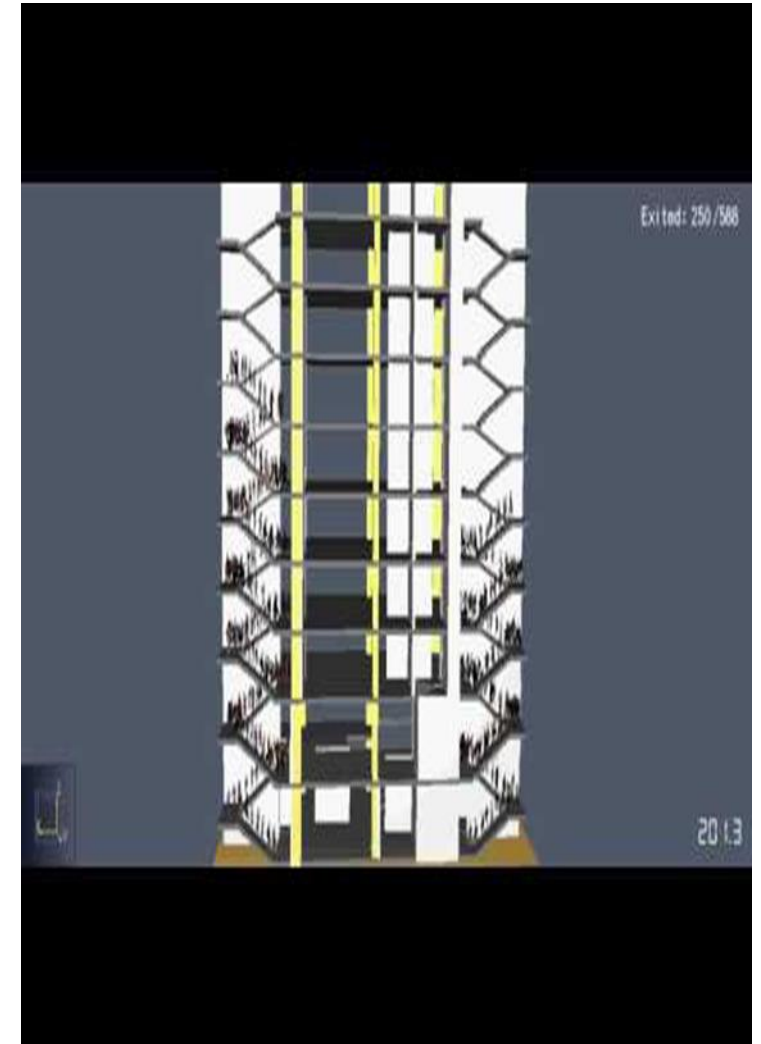


# The impact of people with physical disability on evacuation process

The mobility impaired persons could increase the evacuation time and decrease the flow rate (Koo et al., 2012) + (Gaire et al., 2018) + (Shurin and Apakov, 2001) + (Shimada and Naoi, 2009) + (Thompson et al., 2003).

People with mobility impaired may be needed to transport on long vertical stairs (Manion and Golden, 2004).

One wheelchair user need up to 4 persons to evacuate via stair (Chen et al., 2017).



# Design and Management

Safe evacuation depends on the right design and effective management

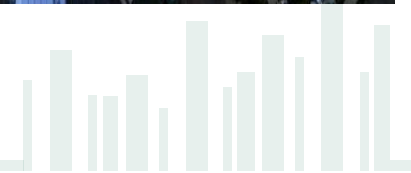
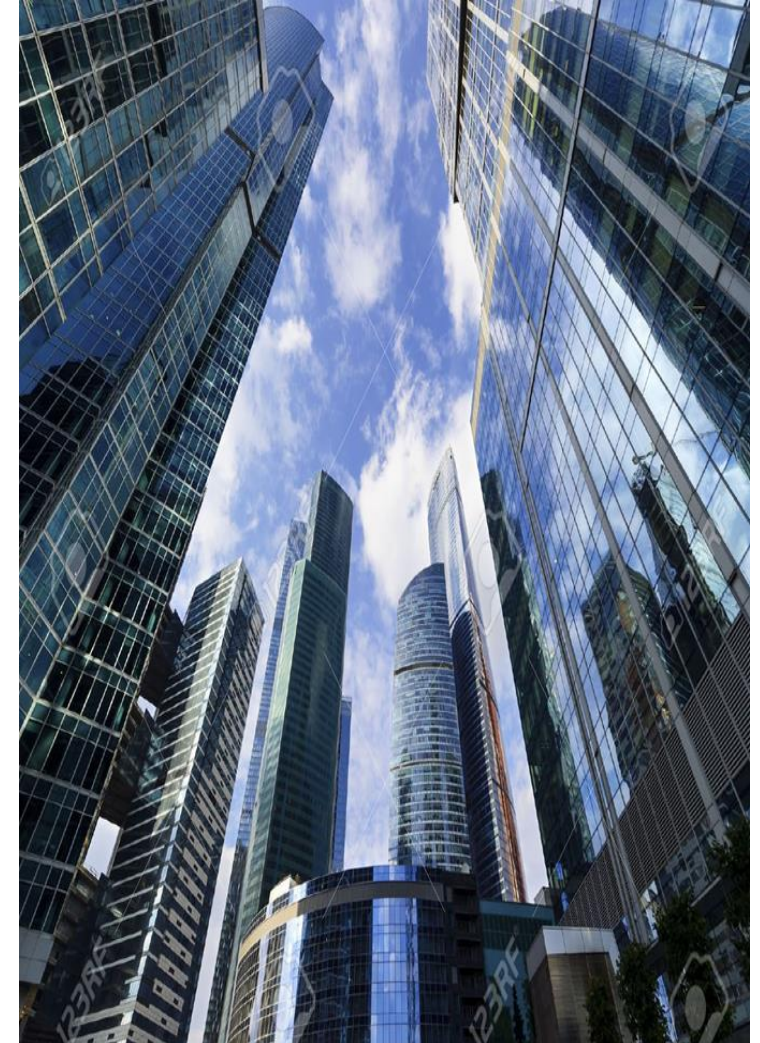
(Boyec,2017)

Evacuation capability (fitness, elder, overweight and other chronic disease) is essential to manage the evacuation process

(Boyce, 2017)+(Koo et al.,2012)+ (NFPA,2018).

Parts of accessible means of egress can include one or more of the internal and external stairs, Refuge area, and Evacuation lifts (SBC 2018).

Multi-agent system strategy is combined with means of egress includes the staircase, the refuge floor or area and the elevators (Chen et al.,2017).



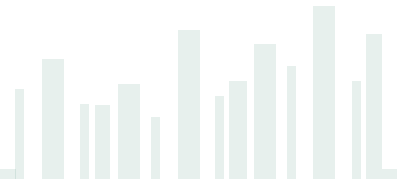
# Stairs

“All vertical evacuation strategies using stairs for people with disability cannot reduce evacuation times ” (Koo et al. 2013).

Evacuated a physical disabilities via stairs may block the way of evacuation for other people (Koo et al., 2012).

The minimum width of the stairs should be around 1,750 mm due to current world demographic (Waldau et al,2007).

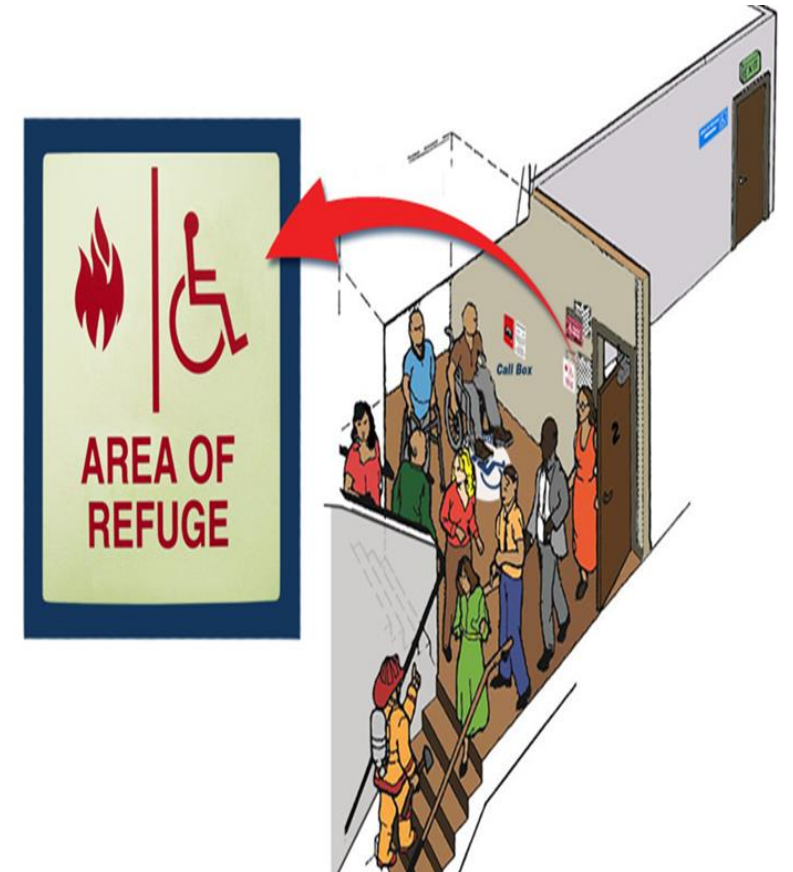
The minimum width of the stair is 1100 mm (SBC,2018).



# Refuge Area

Refuge Area is "an area that is enclosed with fire-resisting construction and served directly by a safe route to a storey exit, evacuation lift, or final exit, thus constituting a temporarily safe space for disabled people to await assistance for their evacuation" (BS 5588,2017).

Refuge area is 'an area where persons unable to use stairways can remain temporarily to await instructions or assistance during an emergency evacuation (SBC 801,2018).



# Communication System

According to NFPA 101,2018, BS999,2017, and SBC 801,2018, the refuge area shall have a two-way communication system.

And the area walls and doors should be fire-resistance construction , and an approved smoke control system shall be in the refuge area.

Using the refugee area needs a clear plan and trained manpower

(McConnell and Boyce, 2015)

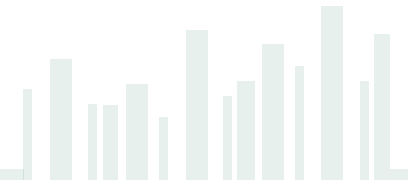
mobility impaired should fully understand and confident to use refuge area.

((McConnell and Boyce, 2015)+(Shields et al. 2009)+(DCLG, 2008)



# Evacuation Elevator

Flow rate of evacuated people significantly increases by using elevators (Manley & Kim 2012)+ (Koo et al.,2013) +(Chen et al. 2017)+ (Ding et al.,2015). One additional interior stairway shall be provided in buildings that are more than 128m in height except it the building having elevators used for occupant self-evacuation (SBC,2018) , there are some fears of people of using elevators (Turhanlar et al.,2013)





# The sample

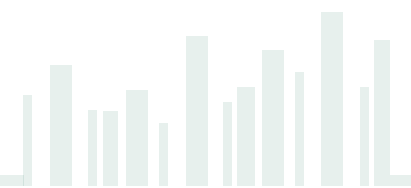
Two criteria of selecting sample

Height > 50 m

Type of Occupancy: office or hotel

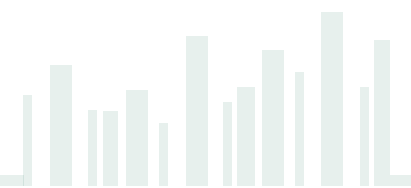
Sample size:

50 → 29 → 16 → 11



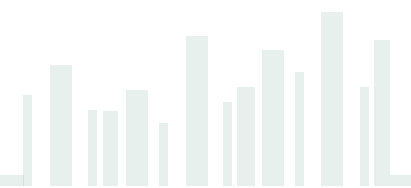
# The sample

Building	Height m	Area m2 (Area of project land)	Occupancy	Years of Experience of the participant (safety manager in the building)
A	More than 200	More than 60000	Hotel + offices + Mall	More than 20 years
B	50 m-100 m	More than 10000	Hotel	More than 10 years
C	50 m-100 m	More than 5000	Hotel	More than 10 years
D	More than 200	More than 60000	Hotel + offices + Mall	More than 15 years
E	More Than 200	More than 10000	Offices+ Apartments	More than 10 years
F	100m-200 m	More than 10000	Offices	More than 5 years
G	50 m-100 m	More than 10000	Hotel	More than 10 years
H	100m-200 m	More than 20000	Hotel + Offices	More than 5 years
I	50 m-100 m	More than 10000	Offices	More than 5 years
J	100m-200 m	More than 5000	Hotel	More than 10 years
K	50m-100 m	More than 10000	Offices	More than 5 years



# Interview development

1. First section: evacuation training and Drills.
2. Second section: the evacuation procedure and the participants 'suggestions.
3. Third section: the types of facilities and devices that are used in evacuation of mobility impaired.



## Results (Training and drills)

The number of drills: 0 in 7 buildings and 2 in 5 buildings

Buildings A, D, E, H, and J :more than 20 safety team members (receive both internal and external training at least twice a year)

In the remaining buildings: safety teams consist of employees with secondary roles (Safety Department trains them)

No agency in Riyadh for mixed ability evacuation training

Buildings A, D, and E: Internal training on how to evacuate people with a mobility impairment. The remaining eight :instructions are adequate.



## Results (Evacuation Procedure for people with disabilities)

The written official evacuation plan for six buildings do not include a section of the evacuation of persons with mobility

**Hotels procedure** : The hotel reception documents the case, then sends an email to the Building Safety Department , the safety department determines the procedures of evacuation.

**The office buildings procedure:**

the case is studied – provide the safety measures needed  
– inform all safety members

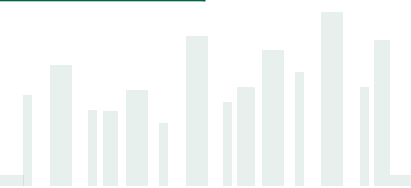
The safety manager in Building D added that the Safety Department sends a monthly letter to tenants to update the data of persons with disabilities information.

In Building C and Building I, the ground floor and the first floor are reserved for people with mobility disabilities.



# Results (Asset facilities and devices)

Placing rooms and offices of people with disability in the lower floors only	Communication system	Refuge floor	Refuge area	Use fire elevator as evacuation elevator	Evacuation elevator	Evacuation Chair	Tower
	Green	White	White	Green	White	Green	A
	Green	Red	Green	Green	White	Green	B
	Green	White	White	Green	White	White	C
	Green	White	Green	Green	White	Green	D
	Green	Green	White	Green	White	Green	E
	Green	Red	White	White	White	White	F
	Green	White	White	Green	White	White	G
	Green	Red	White	Green	White	Green	H
	Green	Red	White	Green	White	Green	I
	Green	Green	White	Green	White	Green	J
	Green	Green	White	Green	White	Green	K



# Recommendations

Evacuation elevators as a requirement for new high rise buildings.

Develop engineering solutions for the existing elevators to become usable for evacuation.

The building management should have the decision to conduct the drills.

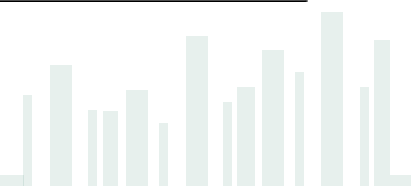
Specialized training centers.

National Workshops

Model buildings

International conferences to exchange experiences

Support scientific research in this field.



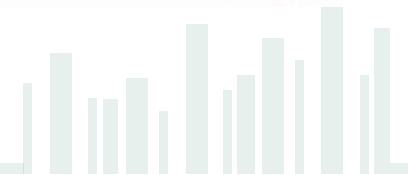
# Conclusion

Cooperation between researchers, code developers, fire safety engineers, and high-rise building management is necessary.

Code developers must review the code based on the changes in the current society in terms of disability or obesity.

Communication between code developers around the world.

There is a need to create new ideas







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Saudi Building Code

# THANKS

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