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Assessing Evacuation Pattern of Elderly in Residential Facilities : A Case of Pune City India

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ABSTRACT

The degree and severity to which old persons are affected in emergencies and disasters depend on the specific characteristics of the person, the type and severity of the hazard as well as the character of built environment and the disaster management systems in place. Ageing causes limitations in movement which in turn increases vulnerability of elderly in several ways. This research focus on analysing complex problems encountered during evacuation with reference to elderly people on occurrence of a disaster. The objective is to find out the architectural features which affect evacuation of elderly occupants of residential buildings in city of Pune India. The role of selected socio-economic and demographic variables and architectural features are explored on evacuation response behaviour of elderly. Spatial characteristics are examined with reference to building typology commonly found in the city in question. The methodology included a questionnaire survey, structured interview and observations. The findings are based on data analysis with use of both descriptive and inferential statistics. It has been argued that evacuation should be considered in architectural and planning as a proactive measure rather than a reaction to disaster occurrence. It is stressed that adequate architectural and planning of residential facilities can facilitate efficient evacuation of elderly and save them from a potential disaster threat.

Keywords: Evacuation, Pune, Elderly, Stress, Panic.

I. INTRODUCTION

The world's population is expanding with more individuals living beyond their sixth decade of life. While there is diversity among older adults worldwide, unique common factors influence the ability of the frail elderly to maintain their health and well-being when faced with a disaster. It has been estimated that, during the 1998-2025 period, the world's elderly population will be more than double while the world's youth will grow by 6 per cent (Gokhale 2009). Old age is coupled with serious physical, cognitive, or psychosocial problems which render elderly people more vulnerable to disasters. Limited mobility diminished sensory awareness, and chronic health conditions, affects the older persons' ability to evacuate and prevent taking appropriate actions (Fernandez et al 2002). Their unique needs, beliefs, and circumstances must be satisfied in disaster responses (Cohen and Mulvaney2005). Ensuring the safety and security of the elderly a challenging task, especially during emergency situations and disasters where a speedy and safe evacuation is essential. This research seeks to establish the role of architecture and planning for enhancing the safety of elderly population living in urban areas of India. Within this context, critical issues are explored such as disaster behaviour and response, evacuation process and its interrelationship with architectural and planning characteristics of built spaces focused on elderly occupants.

Disaster Response

Disasters are considered as a systemic event and social catalyst which result in social disruption and emphasized as the collapse of cultural protection. They are closely related to a situation of crisis which is referred as a collective stress situation where the members of a social system fail to receive expected conditions of life from the system (Gokhale2014 a). Disasters can cause traumatic stress which is a natural response to a perceived threat which is an automatic, human defence reaction and include many physical and psychological adjustments in order to prepare itself to

act physically or to either fight or to flee from the perceived danger. Level of stress is different from person to person but generally it found more in elderly people when they get exposed to elevated stress levels because their logical thinking gets limited (Friberg2015). Under extraordinary circumstances human exhibit inappropriate, excessive or intense fear and or flight behaviour which is referred as panic (Mawson 2005). Stress is a normal reaction to disaster occurrence which motivate people to react and take action (Proulx 2002). The response of an individual in emergency situation depends on the task demands which may exceed the physical and psychological capacity of elderly. The brain is the key organ of the stress response because it determines what is threatening as well as it controls the behavioural and physiological responses of an individual in emergency situation (Gokhale 2014). Physical environment affect evacuation as on exposure to a disastrous situation the person process information perceived in the environment or drawn from past experience to arrive at a decision for next move (Janis and Mann 1977). Another aspect is limited time available to make a decision before crucial options are lost which are to be taken on the basis of ambiguous, incomplete and unusual information which is available (Proulx 1997).

Health status is one of the important factors that affect evacuation process. Many times elderly are found unable to quickly evacuate a building because of pre-existing physical limitations, such as impaired mobility of frail elderly (Imperiale 1991). Here term "frail elderly" referred to the health related conditions that limit the individual's independence, and increase need for assistance and dependency on others (Hobes 1996). In addition the spatial features of the residential facility where they live do not support fast and efficient evacuation(Gokhale 2009). The architectural features needs to be identified which limit mobility of elderly.

II. METHODS AND MATERIAL

This research is conducted in two parts in the first part preparedness and capacity indicators are examined based on Quarantalli's evacuation behaviour model (Quarentelli 1998). In addition structured interviews conducted with elderly residents each of which lasted 20 to 30 minutes which were audio recorded to ensure that accurate records were kept. Second part included an examination of living facilities of elderly with reference to architectural and planning aspects. Two typologies namely, detached houses and multi storied apartments were selected for analysis with a sample size of 5 residential units each. The residential unit were examined with reference to spatial planning aspects and their likely performance with reference to evacuation on occurrence of a disaster.

The primary criterion for selection of participants was their chronological age. WHO have accepted the chronological age of 65 years as a definition of 'elderly' (WHO).This study selected people of 65 years of age as the baseline for selecting participants from electoral voter list. The demographic data and profile was studied after taking informed consent from 250 people. The inclusion criteria were all the individuals who were 65 years of age or older, were permanent residents of the study area. A total of 200 elderly people who met the inclusion criteria were included in the study which is 2.16 % of elderly population living in the study area. Out of 200 excluding 2 incomplete responses, 198 valid and cognizable responses were used for analysis. Data was collected as per a pre-tested and validated questionnaire administered by the investigators.

III. RESULTS AND DISCUSSION

In the present study spatial aspects are examined in residential buildings to explain the variation in evacuation response to emergency situation in context of elderly occupants. In order to present evacuation responses, various physical environmental and demographic variables are included in the present study considering that such variables have an influence on the process towards evacuation process. Included variables are knowledge and awareness, health status, economic level, character of living spaces and preparedness to evacuate in case of occurrence of a disaster. On the other hand, socio-economic, demographic and other relevant variables included in the present study considering these may influence evacuation response. Such variables are age, gender, education level, income, and living arrangement. Chi-square tests are performed between evacuation related variables and socio-economic, demographic and other variables to identify statistically significant associations

Preparedness Indicator:Knowledge and Awareness

The indicators for preparedness of elderly that were used in this study, included: awareness about resources available in case of an emergency, knowledge about what action to take, awareness and knowledge about the building and surroundings knowledge about a specific evacuation destination, awareness regarding implications of a disaster , knowledge about what to take in an evacuation. These indicators were analysed by cross tabulation analysis. The present study finds that 19.69 % respondents were not aware , 40% were aware and had knowledge to some extent, 37.38% were aware while only 3.54% were had adequate knowledge and awareness about spatial character of the building and what to do in occurrence of an emergency situation. For respondents, it is found that the impact of awareness and knowledge is associated with large differences in the pattern of reported preparedness (Table 1).

Table 1. Preparedness and Awareness

Preparedness	Awareness			
	Very much	Aware	Not much	Not at all
Very Much Prepared	2.52 (5)	6.06 (12)	1.51 (3)	0.50 (1)
Prepared	1.01 (2)	12.62 (25)	6.06 (12)	1.51 (3)
To some Extent	0 (0)	13.63 (27)	19.69 (39)	7.57 (15)
Not at all	0 (0)	5.05 (10)	12.12 (24)	10.10 (20)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses.

Elderly with greater knowledge and awareness were found well prepared for evacuation. For the chi square statisticChi square value = 5.977, P = .014, Alpha = .05, is found significant. This indicated that knowledge and awareness has correlation with preparedness to respond on occurrence of an emergency situation.

Preparedness Indicator: Health Status

Respondents were asked to select all disability categories that applied to themselves these disabilities include sensory, physical and cognitive disabilities (Donner 2011). Number of disability reported was considered to find out health status which influences the evacuation process. The 26.2% of respondents reported healthy with no disability, 46.5% with 1 to 2 disabilities, and 24.2% with 3 to 4 disabilities while 3.04% were critical as they reported more than 4 disabilities. The impact of their disability on their preparedness to evacuate is examined with cross tabulation (Table 2).

Table 2. Preparedness and Health Status

Preparedness	Problems			
	No	Minor	Major	Critical
Very Much Prepared	8.08 (16)	2. 52 (5)	0 (0)	0 (0)
Prepared	5.05 (10)	13.63 (27)	2.52 (5)	0 (0)
Prepared to some Extent	9.09 (18)	23.23 (46)	8.58 (17)	0 (0)
Not at all	4 (8)	7.07 (14)	13.13 (26)	6 (3.03)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses
Chi square 16.500, P= 000, df= 1
The significant Chi square indicated the association between preparedness and health status. People with less health problems found capable of taking decision to vacuate and pursue evacuation process faster.

Capacity Indicators: Economic Status

The economic status of respondents examined to find out its association with preparedness (Table 3)

Table 3. Preparedness and Economic Status

	Monthly Income in INR			
	More than 25000	10000-25000	Up to 10000	No Income
Very Much Prepared	4.54 (9)	5.05 (10)	1.01 (2)	0 (0)
Prepared	3.03 (6)	11.11 (22)	7.07 (14)	0 (0)
To some Extent	1.51 (3)	11.61 (23)	19.69 (39)	8.08 (16)
Not at all	1.01 (2)	4.54 (9)	15.65 (31)	6.06 (12)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses

Chi square value = .562 ,d.f. = 1, P = .454 ($p < .05$ at 95% level)

Chi square statistics indicate that there is no significant association between economic status and preparedness. The pattern of preparedness was found not affected as far as the respondents belonging to different income groups are concerned.

Capacity Indicator: Support Available

Table 4. Availability of Support and Preparedness

Preparedness	Support Available			
	from Family	from Spouse	from Neighbours	No support
Very Much	5.55 (11)	3.53 (7)	0.50 (1)	1.01 (2)
Prepared	7.07 (14)	10.06 (21)	1.01 (2)	3.03 (6)
To some Extent	29.29 (58)	9.09 (18)	1.51 (3)	3.53 (7)
Not at all	7.57 (15)	12.62 (25)	2.52 (5)	1.51 (3)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses
Chi square value = 1.383 P = .240 df.=1 significance level at .05

Chi square value insignificant as p value is greater than alpha .05 (.240 > .05) null hypothesis sustains that there is no significant association between preparedness to face disaster and support available.

Capacity Indicators: Spatial Features

Spatial features were examined where questions were asked to the respondents regarding building typology, number of floors in the building, their location within the building, locations and numbers presence of refuge spaces. The responses were analysed across the four identified building typology to identify the degree of vulnerability (Table 5)

Table 5. Vulnerability With Reference to Spatial Features

	Ground Floor	Apartment up to 4 floors	Apartment 5-10 floors	More than 10 floors
Good	5.05 (10)	6.06 (12)	5.05 (10)	0 (0)
Not vulnerable	8.58 ((17)	19.69 (39)	13.13 (26)	0 (0)
Vulnerable	0.05 (1)	13.13 (26)	10.06 (21)	2.5 (5)
Highly Vulnerable	0 (0)	3.03 (6)	9.59 (19)	3.03 (6)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses
Chi square = .056 ,d.f. = 1 , P = .813 (P> .05 at 95% level)
Chi square value found insignificant indicating that there is no significant association vulnerability and location in terms of on which floor occupants live.

Capacity Indicators: Interior Design Features

Respondents were asked to identify the interior design features of which they find problematic and adversely affect evacuation. The variables included the room layout, adequacy of furniture,distance from main exit of the residential unit,lighting and ventilation the location and number of exits, corridor patterns and widths, staircaselighting, signage and presence of barriers along the evacuation route. The analysis is based on number of problems identified by respondents in the residential units they live (table 6)

Table 6. Interior Design Features

Number of Problems	Detached House	Apartment up to 4 floors	Apartment 5-10 floors	More than 10 floors
2 problems	5.05 (10)	3.03 (6)	1.01 (2)	1.01 (2)
2-4 problems	5.55 (11)	26.26 (52)	4.04 (8)	2.02 (4)
4-6 problems	3.53 (7)	11.61 (23)	17.67 (35)	1.01 (2)
8 and more	0 (0)	1.01 (2)	15.65 (31)	1.51 (3)

Note : Table displays column percentage; frequency counts for each cell are shown in parentheses
Chi square = 52.4112, d.f. =1, P = .000 (P< .05 at 95% level)

Chi square statistics indicated significant association between problem in interior features and building typology.The inadequacy of furniture found in terms of height as in case of more height of bed or chair there is a possibility of fall while standing and move to evacuate. On the other hand smaller height needs more effort for the same. Excessive or inadequate placement of furniture results in indirect often zigzag route resulting in a complex movement pattern which is not favorable in the present context. Greater distance of the occupant's place from main exit of the residential unit has implication with travel time as more travel time does not support fast and efficient evacuation. Lesser width of corridors and passages coupled with complicated layout adversely affect the fast evacuation. Presence of level difference or a threshold along the evacuation route hinders evacuation process by and large. Inadequately designed interior spaces result in confusion, loss of orientation and consequent increased stress. This phenomenon established the importance of planning and designing considering the particular requirement for evacuation and addressing the problems associated with the evacuation process which is different for different building typology.

Study Part II: Observation

The sample included 5 detached houses and 5 apartments (2, 3, 6, 8 and 12 storied). Architectural and planning features were examined with the checklist consisted of a series of 36 questions pertaining to the eight criterion viz. circulation pattern, room layout, lighting condition, ventilation, furniture arrangement, distance to outdoor environment, accessibility in terms of universal design concept and equipment support. Analysis revealed theinadequacy of architectural and planning features in more than 70% of residential units. Presence of highly inadequate equipment support like presence of grab bars, hand rails is noticed in 80% of sample followed by unsatisfactory circulation pattern, room and furniture layout. 70% of the studied facilities were not found accessible for elderly particularly who use wheel chair, light and ventilation was not also found adequate which is supposed to adversely affect evacuation process. The results of analysis of spatial features of residential units based on check list and discussions with the occupants for are shown in Fig. 1.

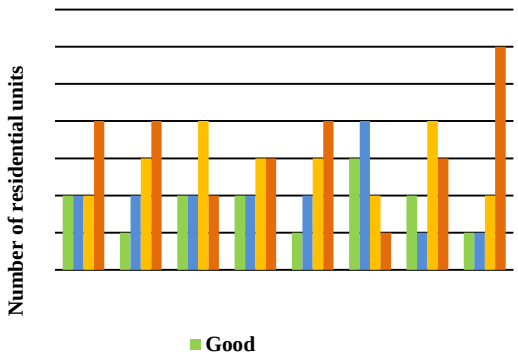

Figure 1. Architectural and Planning Indicators.

Respondents with high income level live more luxurious life where house interiors are found full of furniture. Presence of excessive furniture was reportedly perceived as obstruction as there is no clear path left to navigate in ease. More than 60% residences were found complicated in terms of spatial arrangement navigation through such spaces was not found comfortable as reported by the respondents that they get confused by frequent changes in direction or turnarounds. Width of available navigation route found less than required as per requirement of building codes and universal design criteria which is a matter of serious concern as far as building plan in concerned. Presence of many doors and choices to evacuate as noticed in 8 storied apartment where occupants reported loss of orientation. Presence of excessive furniture particularly in smaller apartments which is commonly noticed is perceived as obstruction while navigating within the limited space available in such typology. Insufficient light is one of the aspects which render evacuation difficult for elderly suffering with visual impairment. In sufficient light also add to loss of orientation and increase the possibility of banging against objects present along the evacuation route or even may result in fall. Presence of excessive number of exits particularly found in detached houses can result in a state of confusion and delay in taking decision regarding selection of evacuation route.

IV. CONCLUSION

The overall findings of this study lead to conclude that architectural and planning features of residential buildings in study area Pune are not adequately designed considering the needs of elderly in context of evacuation in emergency situations. High rise apartments were found susceptible in light of evacuation particularly for elderly occupants staying at upper floors. Absence of adequate lighting add to difficulty in evacuation as it hamper wayfinding process. No consideration for accessibility in planning and design noticed which is a matter of concern specially for elderly who use wheel chairs or walkers. Need to travel a longer distance to come out of building in case of emergency particularly in apartment typology may present serious consequences.Elderly prefer simple and linear planning as complicated building layout result in chaos which affects the evacuation process.

Knowledge about disaster occurrence as well as action to be taken is an important aspect which is not found satisfactory. Larges apartments have more rooms where location of room occupied by elderly may be located at greater distance from the main exit which result in delay in egress. The increasing number of casualties reported occurring in past events establishes that preventive design-related and organizational measures have not been taken in Indian context. This research established the role of spatial features in emergency situation and its influence on the right choice of evacuation routes. It is suggested that the potentials of architectural and planning optimizing the safety of users in buildings must be included to the architectural design and planning process. It is necessary for architects and

planners to investigate spatial character of buildings with reference to crowd dynamics under stress and panic and explore behaviour of people under spatial constraints. It calls for exploration of egress simulation and stress analysis of various spaces in buildings which is supposed to help architects and planners to render building design safer. Codes consider availability of egress routes but do not consider the effects of potential blockage of ways out on time evacuation. They also do not review evacuation time, human behaviours or abilities in emergency. Efforts are to be made for appropriate planning measures for efficient evacuation on occurrence of a disaster from architectural and planning perspective. There is an urgent need for understanding and addressing the problems of elderly people as far as architectural and planning aspects with reference to evacuation is concerned. It calls for creating awareness, training, and provision of security measures in living areas for capacity building. Architects and planners must understand psychological issues with reference to disaster occurrence in order to help in creation of a resilient habitat,

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