


Article

Quantitative Interpretation of Universal Design Features in Shopping Malls: A Case Study in Kolkata, India

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Abstract: United Nations Sustainable Development Goal 11 indicates the need for and importance of inclusive public spaces as a prerequisite towards sustainable cities. Shopping malls in urban India attract a significantly large population daily, making them an important typology of urban structures which deserve universal design. Thus, in this paper, universal design features of shopping malls in Kolkata have been considered. Despite a significant increase in the number of elderly and specially-abled people, civic administration in Kolkata has not been able to successfully implement the national guidelines on inclusiveness in its shopping malls. Five shopping malls from the Kolkata Municipal Corporation were considered case areas for the fieldwork. The accessibility audit checklist included in the 'Harmonized Guidelines and Standards for Universal Accessibility in India 2021' published by the Ministry of Housing and Urban Affairs, Government of India, has been used in this paper. It was found that the accessibility percentage of shopping malls ranges between 14.4% and 44.8%, indicating the lack of universal design considerations. Pearson's correlation between the year of establishment and the accessibility percentage of each case area was found to be -0.66 , indicating an alarming deterioration in universal design considerations over the years. On comparing the accessibility performance with the diverse user groups, it was found that individual wheelchair users are likely to face the most difficulty in the case areas with a median accessibility value of 41.46%. This research indicated that accessible continuity in shopping malls in Kolkata can be imparted only by implementing case-specific universal design assessment through a primary survey.

Keywords: UN-SDG 11; universal design; accessibility audit; accessible continuity; shopping malls; Kolkata



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1. Introduction

Enhancing the degree of inclusiveness in urban planning and management vide United Nations Sustainable Development Goal 11 (hereafter, UN-SDG 11) target number 3 [1] and ensuring inclusiveness in public spaces vide UN-SDG 11 target number 7 [2] are overarching global suggestions for members of the UN. Post-2014, India has made significant improvements in this domain [3]. However, owing to the national focus on making public infrastructure inclusive, the segment of shopping malls (which primarily falls in the private domain) has remained ignored by architects and city planners.

Based on personal observations and accessibility audits, the built environment in shopping malls of Kolkata, India, lacks universal design features. The population of Kolkata Municipal Corporation has declined by 1.69% from 4,572,876 in 2001 to 4,496,694 people in 2011 [4]. However, it is still a densely populated city with a density of over 24,300 people per square kilometer, compared to the state (prefecture) density of 1028 people per square kilometer and national density of 368.35 people per square kilometer [5]. In addition, the

share of specially-abled people increased from 2.36% in 2001 to 2.70% in 2011 [6]. The share of elderly people also rose from 9.90% in 2001 to 11.77% in 2011 [7]. Thus, research which facilitates the functional usage of spaces by all/diverse user groups is relevant. Similarly, in Kolkata, universally designed built environments which benefit all, including the specially-abled and elderly, are now a necessity rather than an additional building feature. Moreover, the relatively high footfall in shopping malls (amongst various commercial buildings) poses a professional responsibility towards the architects and planners to ensure universally designed shopping malls. However, the recent National Missions/Initiatives in India (like the Accessible India Campaign 2015) are focused on Public/Government buildings. Additionally, in comparison to the existing national guidelines of India, the relevant urban building by-laws of Kolkata Municipal Corporation (KMC) demand minimal universal design criteria for the building sanction process. Thus, it is no surprise that there is an absence of universally designed shopping malls in Kolkata.

In the wake of the increasing urbanization in India, improving its citizens' quality of life is of utmost importance [8]. However, factors like (a) urban complexity, (b) constitutional provisions, (c) the disparity between the urban and rural planning paradigms, and (d) the lack of adequate guidelines make India a difficult environment for the implementation of universal design guidelines [9]. In particular, cities like Kolkata, which have evolved from old historic towns under pre-British rule to a megacity in the 21st century, often experience difficulty in maintaining the universal design guidelines in their built environments [10].

Being a historic city, Kolkata has traditional shopping sectors which are affordable and organically developed. However, the advent of modern retail experience in the recent past has influenced the affordable, mid-segment, high-end, and luxury segment customers to embrace the shopping mall culture [11,12]. Roy (2014) argues that the reason Kolkata is swaying towards shopping malls is due to the availability of multiple shopping categories, including (a) a single location, (b) reliable quality, (c) absence of bargaining, (d) exposure to customer-friendly shopping discounts, (e) comfortably conditioned spaces, and (f) ease of parking facilities [13]. The location of the shopping malls, including the vicinity of transportation nodes, is a major factor in the pedestrian footfall of a shopping mall. In Kolkata, choosing shopping malls over traditional shopping spaces is often considered a status symbol or a sophisticated way of living among users [14]. Subsequently, physical planning plays a crucial role in assuring the aforementioned convenience [15]. However, researchers have seldom considered the need to include universal design factors while analyzing shopping malls in the Indian context [16]. Concerning this, imitating the Western model of redeveloping shopping malls is also inappropriate, since the two contexts differ with regard to various factors like locations, architecture, and mall infrastructure [17]. Particularly in cities like Kolkata, the issues are much more complex compared to the other cities in India [18]. Thus, the research on universal design features and their accessible continuity in shopping malls in Kolkata, India, is apt.

The paradigm shifts in the inclusive approach in India began in 2015, when the Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment started the 'Accessible India Campaign' which focused on inclusive approaches in the built environment, transportation sector, and information processes. This is the only mission in the history of India that provides an accessibility audit guideline. The latest guideline was published in 2021 by the Ministry of Housing and Urban Affairs titled 'Harmonized Guidelines and Standards for Universal Accessibility in India 2021' [19]. This document is closest to the notion of universal design. For this paper, the 'Harmonized Guidelines and Standards for Universal Accessibility in India 2021' have been referred to while conducting the pilot surveys and qualitative studies in the case areas. The 'Harmonized Guidelines and Standards for Universal Accessibility in India 2021' include a notion of creating a universally accessible and inclusive India. These standards also aim to strengthen a national compulsion for an accessible and self-reliant India. The guideline includes the following chapters: (a) Accessibility, Diversity, and universal design; (b) External elements in a built environment; (c) Internal Element; (d) Signage and Information

Systems; (e) Building Typologies; (f) Building Operations and Maintenance; (g) Evaluating Accessibility. The guideline has been issued by the Ministry of Housing and Urban Affairs, Government of India. For quantitative studies on the case areas, the accessibility audit format provided during the 'Accessible India Campaign' has been used.

This paper aims to verify the universal design features in shopping malls in Kolkata, India, and propose their accessible continuity through design intervention. This paper seeks to answer the following questions: (a) How accessible are the shopping malls in Kolkata? (b) What are the design possibilities that could make the existing shopping malls more accessible?

The hypothesis for this paper is that shopping malls in Kolkata, India, have inadequate universal design features. The objectives framed to strengthen the aim of this paper are as follows: (a) to understand the condition of universal design in shopping malls of Kolkata, (b) to evaluate the extent of universal design possible in existing shopping malls of Kolkata, and (c) to provide recommendations for improvement of universal design features at shopping malls in Kolkata.

The limitations of this paper are as follows: (a) the case area selection is limited to the Kolkata Municipal Corporation and (b) movement-based disability is prioritized.

2. Materials and Methods

2.1. Research Methodology

The research methodology is divided into 5 major segments: (a) literature study, (b) case study, (c) data collection, (d) data analysis, and (e) proposal; as illustrated hereafter. The first segment, 'literature study', is composed of (a) demography, (b) statutory guidelines, (c) best practices, (d) conceptualization, (e) shopping malls, and (f) pilot study. A pilot study was undertaken in City Centre 1, Axis Mall, and Forum Mall, under the statutory control of Bidhannagar Municipal Corporation, New Town Development Authority, and Kolkata Municipal Corporation, respectively. The focus of the pilot study was a baseline assessment of the case areas with respect to the existing Indian accessibility guidelines.

In the second segment 'case study', 5 shopping malls in the Kolkata Municipal Corporation were delineated as the case area for this paper: (a) Mani Square, (b) Forum Mall, (c) Quest Mall, (d) South City Mall, and (e) Acropolis Mall. The following segments are data collection and data analysis, respectively.

The third segment, 'data collection', is composed of qualitative and quantitative analysis. Qualitative analysis is based on visual observation of the case areas through a universal lens. The quantitative analysis is based on the questionnaire survey of the case areas based on the parameters mentioned in the following segment. The quantitative survey is further evaluated to study: (a) the overall performance of each survey parameter for the entire survey and (b) the overall accessibility condition of each case area.

The fourth segment, 'data analysis', includes 3 stages: (a) correlation, (b) user group study, and (c) spatial interpretation. A correlation is established between the year of establishment of the case areas and (a) respective overall accessibility percentage and (b) the average accessibility percentage of each survey parameter for the entire survey. Mapping the relative accessibility percentage for all shopping malls across different user groups followed by mapping the average accessibility percentage of each parameter is the constituent of the user group study. Physical interpretation of accessible routes based on the origin–path–destination in case areas is the last part of this segment. The methodology as described above is illustrated below in Figure 1.

2.2. Case Area

Kolkata Municipal Corporation is the local government of the city of Kolkata, the capital city of West Bengal. It was established in 1876. The total area of this civic administrative body is 185 square kilometers. It consists of 144 wards in total. The total population is 4,496,694 and the density is 24,306.45 persons per square kilometer, as per the Census of India conducted in 2011.

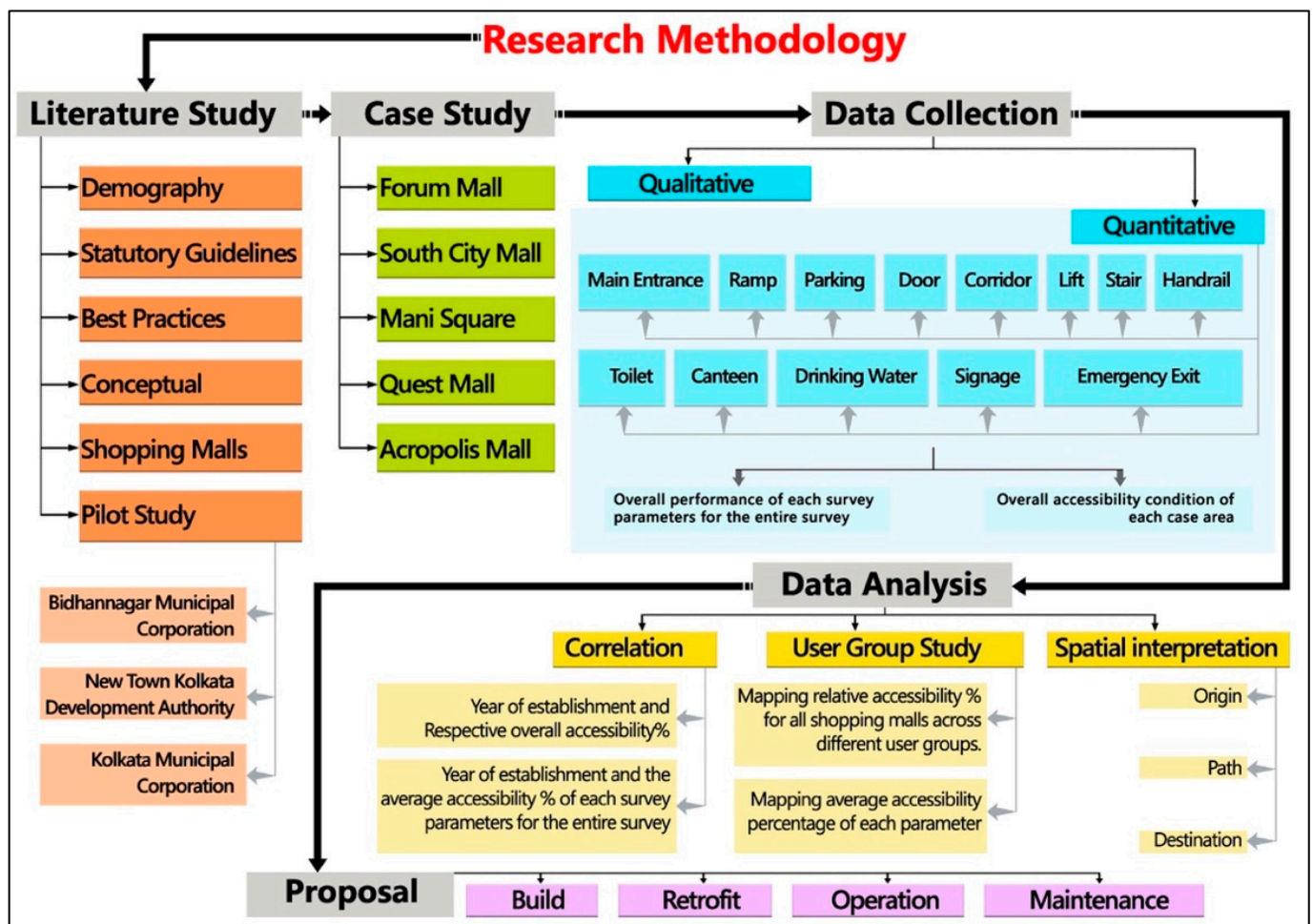


Figure 1. Research methodology [source: author].

Case areas have been selected from the locations which are listed under Kolkata Municipal Corporations (KMC). The process of selection was performed under three criteria as follows. Firstly, the case areas were selected from the major locations within the city. Secondly, the year of construction of the shopping malls (selected based on a 5-year gap between Forum Mall in 2003, which was the first mall to be built in Kolkata, and two additional malls that were constructed in 2008 and then two more that were built in 2013) was considered to establish the correlation between the year of establishment of the shopping malls and the accessibility around Kolkata. Lastly, the case areas were selected to avoid being situated in locations that were near to each other. Figure 2 below shows the locations of the case areas. Subsequently, Table 1 shows the details of the selected case areas.

The accessibility audit format has been referred from the Harmonized Guidelines and Standards for Universal Accessibility in India 2021 by the Ministry of Housing and Urban Affairs, Government of India. The guideline consists of both internal and external building features for consideration. The features considered for accessibility analysis have been deemed as parameters by the author. The 12 parameters considered are (1) main entrance, (2) ramp, (3) parking, (4) door, corridor, (5) lifts, (6) stairs, (7) handrail, (8) toilet, (9) canteen, (10) drinking water, (11) signage, and (12) emergency exit. The individual parameters are analyzed based on associated indicators that describe each parameter by referring to details that are essential for making the parameter accessible.

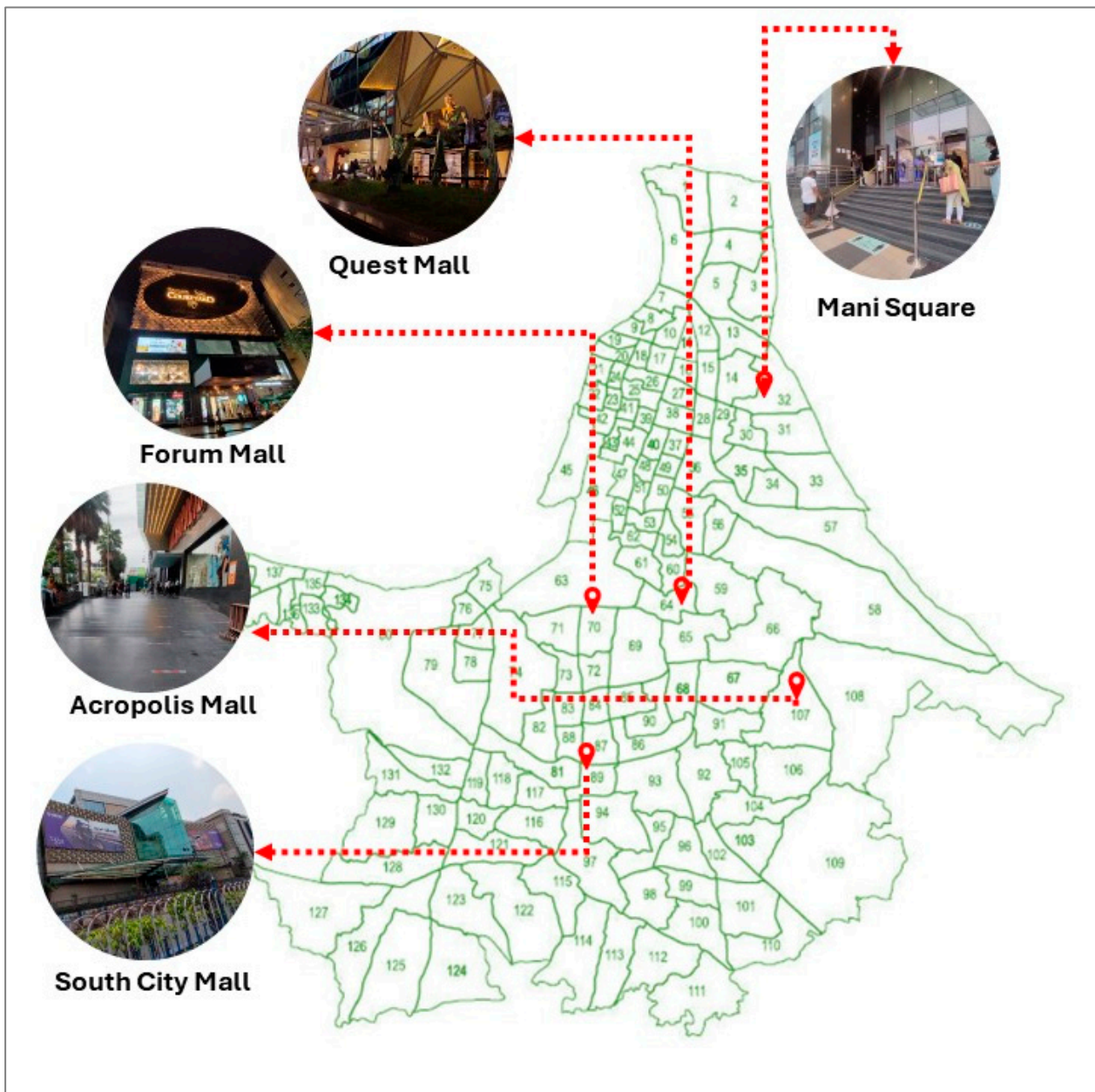


Figure 2. Location of the case areas [Source: Author’s interpretation on open-source map].

Table 1. Table showing details of the selected case areas [Source: author].

S. No.	Case Areas	Location	Ward No.	Year of Opening	Construction Area (In Square Meters)
1	Forum Mall	Bhowanipur	65	2003	17,271.6
2	South City Mall	Jadavpur	96	2008	92,903.04
3	Mani Square Mall	Eastern Metropolitan Bypass	31	2008	650,321.28
4	Quest Mall	Beck Bagan Row	70	2013	650,321.28
5	Acropolis Mall	East Kolkata Township	70	2013	650,321.28

2.3. Survey Procedure

The accessibility mapping was initiated after selecting the case areas across Kolkata. The process of mapping started with the help of the Accessible Audit checklist. The audit checklist was prepared in a Google form format so that the observation could be entered directly into the datasheet. The data sheet is available via the Google form link: <https://forms.gle/d4K1DpjUBPaRsQMK7>, accessed on 12 April 2024. Each parameter and its indicators were observed in each of the case areas separately. The Forum Mall was surveyed in April 2021. The next survey was conducted in South City Mall in May 2021. The next mall that was surveyed was the Mani Square Mall, which was surveyed in August 2021. In October 2021, the survey for the Quest Mall was conducted. Lastly, the newest mall, which is Acropolis Mall, was surveyed in January 2022. Each parameter and its indicators were observed in each of the case areas separately.

2.4. Quantitative Measures of the Survey

- **Main Entrance:** The main entrance parameter has indicators such as (a) the presence of steps, (b) handrails for steps, (c) handrails on both sides, (d) the presence of a ramp, (e) handrails for ramps, (f) handrails on both sides, (g) door width of 1000 mm, (h) independent door operation, (i) door-handle height between 800 and 1000 mm, (j) permit to access to an elevator, (k) identification of an accessible entrance, and (l) a non-slippery landing surface.
- **Ramp:** The ramp parameter includes indicators such as (a) the provision of ramps next to the stairs, (b) identification of the location of the ramp, (c) a ramp gradient 1:12, (d) a landing measurement of 1500 × 1500 mm, (e) the top and bottom of the ramp being clear of obstructions, (f) the presence of a landing at every change in direction, (g) the presence of a landing at the top and bottom of the ramp, (h) a minimum ramp width of 1500 mm, (i) a continuous handrail on both sides with a height between 760 mm and 900 mm, (j) a non-slip ramp surface, and (k) edge protection on the sides of the ramp.
- **Parking:** The parking parameter includes indicators such as (a) the availability of accessible parking facilities, (b) the number of accessible parking spaces, (c) the marking of the international symbol of accessibility, (d) whether the space is misused by non-disabled people, (e) a curb in the drop-off area, (f) a drop-off marked by signage, and (g) an accessible path from drop-off to the main entrance.
- **Door:** The door parameter includes indicators such as (a) the presence of an automatic door at the entrance, (b) the doors can be operated without much effort, (c) sufficient opening intervals of automatic doors, (d) the height of the push-button for the automatic door is at 1000 mm, (e) space of 450 to 600 mm beside latch side, (f) accessible door placed next to revolving doors, (g) color band marked on glazed doors, (h) width of 1000 mm for at least on a leaf of double-leaved doors, (i) extra pull handle for spring closers, and (j) manual door accessories lower than 800 mm.
- **Corridor:** The corridor parameter includes indicators such as (a) an unobstructed width of at least 1500 mm, (b) maneuvering through the length of the corridor, (c) differences in levels are bridged by ramps or lifts, (d) a sightless person can detect protruding objects, (e) hanging obstructions are mounted above the minimum height of 2200 mm, and (f) a non-reflective counter surface.
- **Lifts:** The lift parameter includes indicators such as (a) an accessible path to the elevator, (b) a clear door opening of 1000 mm, (c) a minimum internal dimension 1500 × 1500 mm or 13-person capacity, (d) the height of the call button is between 800 and 1000 mm, (e) the height of the control panel is between 800 and 1000 mm, (f) an audio/video system is installed, (g) braille/raised numbers on the control panel, (h) color contrast on buttons, (i) provision of a mirror on the opposite side of the lift door, (j) a handrail on three sides, (k) the height of the handrail is between 800 and 1000 mm, (l) easy to identify, (m) emergency intercom availability, (n) tactile or braille instructions for the communication system, (o) emergency intercom usable with voice

communication, (p) door opening/closing interval, and (q) a skid-resistant elevator floor.

- Stairs: The stair parameter includes indicators such as (a) a minimum width of 1200 mm, (b) continuous handrails on both sides at a height of 760 to 900 mm, (c) handrails in the center of the stairs, the width of which is more than 3000 mm, (d) provision of a ramp/lift as an alternative, (e) a landing length no less than 1200 mm, (f) step edges of a different texture, (g) warning blocks at the beginning or end of the flight of stairs, (h) identification of emergency stairs, (i) height of riser of a maximum of 150 mm and minimum tread of 300 mm, (j) treads with a non-slip surface, and (k) risers with open gaps.
- Handrail: The handrail parameter includes indicators such as (a) a mounting height between 760 to 900 mm, (b) easy to grip, (c) securely attached, (d) the handrail extends horizontally 300 mm from the top and bottom of every staircase and ramp, (e) the endings of handrails are grouted in the ground or turn downward, (f) the space between the handrail and the wall is no less than 50 mm, (g) the handrail is painted with contrasting colors, and (h) there is tactile strip/braille plate identification on the handrails for the emergency stairs and floor levels.
- Toilet: The toilet parameter in this paper includes indicators such as (a) the presence of an accessible toilet, (b) identification of the toilet, with sufficient space of 2000 × 2200 mm inside the toilets to allow users to maneuver a wheelchair, (c) space between the WC and the closest adjacent wall, (d) the toilet is fitted with a grab bar between 450 mm and 500 mm, (e) the lower edge of the mirror positioned at a height that does not exceed 1000 mm, (f) accessible showers are provided with a folding seat, (g) grab bars are installed near the WC and showers at a height between 750 and 850 mm, (h) wall-mounted grab bars have knuckle space of 50 mm, (i) there are non-slip grab bars, (j) the grab bars can withstand a load of 200 kg minimum, (k) the faucets are easy to grip and operate with one hand, (l) the shower fixtures have at least 1500 mm long hoses, (m) the hot water pipes are insulated or covered, (n) there is an emergency alarm system, (o) the door lock from the inside is releasable from the outside in an emergency situation, (p) the flushing system is easy to operate, (q) there is skid-proof floor material, and (r) there is a pivoted door which opens outwards.
- Canteen: The canteen parameter focuses on indicators such as (a) the eating outlets have disabled access, (b) there is a circulation path of at least 900 mm, (c) there is an accessible table height of 750 mm to 850 mm, (d) the knee space is 750 mm wide and 480 mm deep, (e) there are fixed stools with space for wheelchairs, and (f) the pivoted doors open outward.
- Drinking water: The drinking-water parameter has indicators such as (a) an accessible water tap, (b) easy maneuvering, (c) a dry area, (d) glasses are provided, and (e) water fountain heights are at different levels, where the minimum height is 750 mm.
- Signage: The signage parameter includes indicators such as (a) the international symbol of accessibility, (b) signs indicating the locations of accessible facilities, maps, (c) information panels and wall-mounted signs are placed at a height between 900 mm and 1800 mm, (d) the color of signs is distinguishable, (e) the surface of the sign is designed to prevent glare, (f) the sign is supplemented by text in embossed letters or braille is available next to the information signs, and (g) the lettering size is proportional to the reading distance.
- Emergency Exit: The emergency exit parameter includes one indicator, i.e., clear markings with directional arrow signs.

3. Results

3.1. Performance of Each Parameter

In this section, the accessibility performance of the parameters (main entrance, ramp, parking, door, corridor, stair, lift, handrail, toilet, drinking water, signage, and emergency

exit) is elaborated upon. The performance is expressed (in percentages) as an outcome of how many accessibility features are present out of the total requisite ones.

- **Main Entrance:** The survey shows that the accessibility percentage of the main entrance for Forum Mall is 69.23%, that for South City Mall is 38.5%, that for Mani Square is 69.23%, that for Quest Mall is 30.8%, and that for Acropolis Mall is 38.5%. Based on these data, we can understand that the minimum percentage of accessibility was found for Quest Mall compared to the other case areas.
- **Ramp:** The survey indicates that the accessibility percentage of the ramp parameter for Forum Mall and South City Mall is 54.55%, for Mani Square it is 72.73%, and for Quest and Acropolis Mall it is 0% because of the absence of any ramps in both these malls.
- **Parking:** The survey suggests that due to the unavailability of any accessible parking facility (according to the guidelines followed for the research) in any of the case areas, the percentage of accessibility of parking parameter is 0% in all case areas.
- **Door:** The survey suggests that the accessibility percentage for doors in Forum Mall is 60%; that for South City Mall, Mani Square Mall, and Acropolis Mall is 40%; and that for Quest Mall is 20%. The lowest accessibility percentage of the door parameter belongs to Quest Mall.
- **Corridor:** The accessibility percentage of corridor parameters for Forum Mall is 83.3%; for South City Mall and Quest Mall, it is 66.7%; for Mani Square Mall, it is 50%; and the minimum accessibility percentage for Acropolis Mall is 33.3%.
- **Lifts:** The accessibility percentage of the lift parameter for Forum Mall is 83.3%; that for South City Mall is 66.7%; that for Mani Square Mall is 50%; that for Quest Mall is 66.7%; and the minimum percentage of accessibility is in Acropolis Mall, for which it is 33.3%.
- **Stairs:** The accessibility percentage of Forum Mall is 45.5%; for South City Mall and Mani Square Mall, it is 36.4%; for Quest Mall, it is 27.3%; and for Acropolis Mall, it is 18.2%, which is the minimum percentage as compared to other case areas.
- **Handrail:** The accessibility percentage for Forum Mall and Mani Square is 62.5%; for South City Mall and Quest Mall, it is 37.5%; and for Acropolis Mall, the percentage is 0%, which is the minimum.
- **Toilet:** The percentage of accessibility for Mani Square Mall is 80% and the minimum percentage of accessibility in Forum Mall, South City, Quest Mall, and Acropolis Mall is 60%.
- **Drinking water:** The accessibility percentage for Mani Square is 20% and the lowest percentage is 0%, which is the case for Forum Mall, South City Mall, Quest Mall, and Acropolis Mall.
- **Signage:** The survey suggests that the accessibility percentage of the signage parameter in Quest Mall is 12.5% and that Forum Mall, South City Mall, Mani Square Mall, and Acropolis Mall have the lowest percentage, which is 0%.
- **Emergency Exit:** For this parameter, all the case areas have a 0% accessibility percentage because of the absence of clear markings with proper directional signs. The directional arrow in all the case areas does not lead any individual directly to the emergency exit. The markings are not continuous. There are many corners in the case areas where there is no directional sign, which results in users looking for the directional signs inside the building.

3.2. Overall Performance of Each Survey Parameter in the Entire Survey

To understand the average performance of each parameter across all case areas, the following analysis is performed. This calculation has been performed to explain the situation related to each parameter individually. Figure 3 represents the mapping of the average accessibility percentage of each parameter across all case areas. In this study, it is derived that the parameter canteen has the highest percentage of accessibility, which is 64.00%, whereas parking and emergency exits have the lowest percentage, which is 0%. These data describe the accessibility of corridors in the surveyed shopping malls as being

in a better situation than the rest of the surveyed parameters. Table 2 shows the average accessibility percentage of each parameter across all case areas.

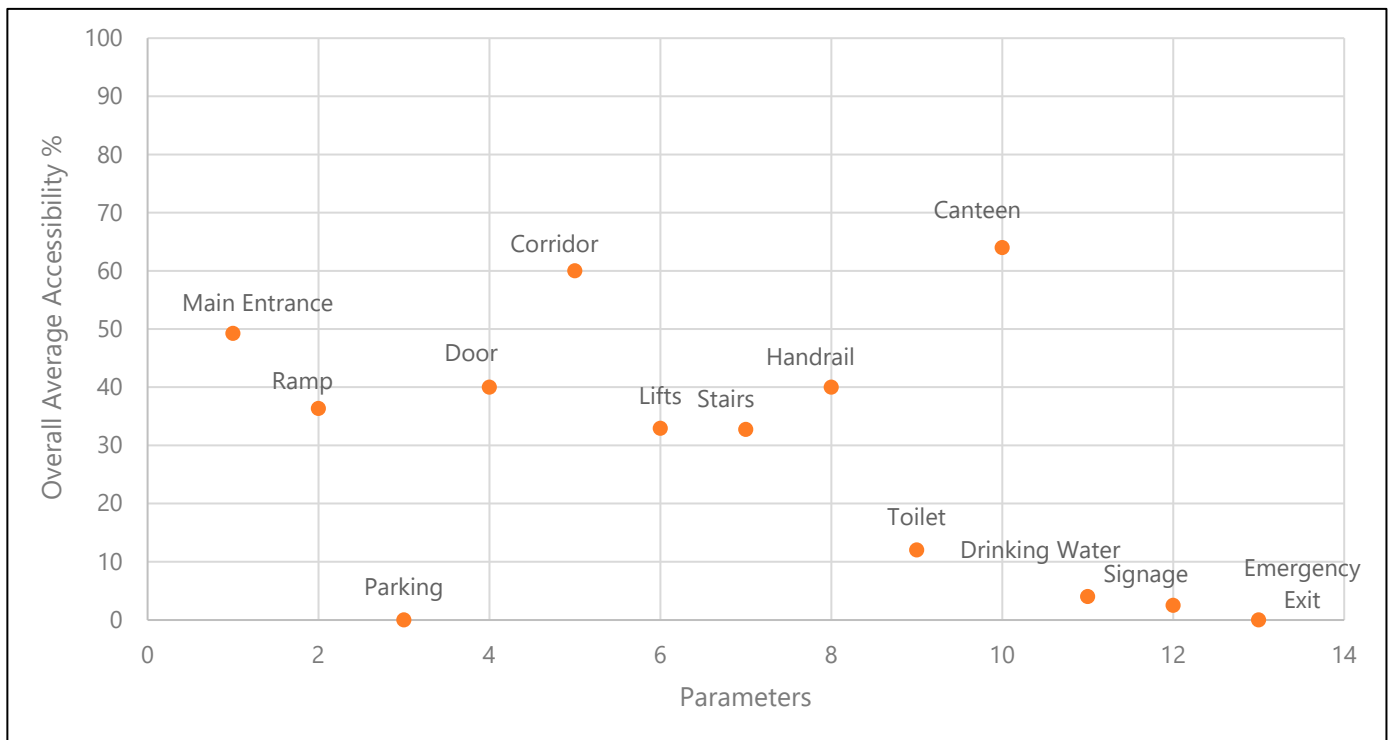


Figure 3. Graph showing the mapping of the average accessibility percentage of each parameter with respect to all the case areas [Source: author].

Table 2. Table showing the average accessibility percentage of each parameter across all case areas [Source: author].

Sl. No.	Parameter	Average Accessibility Percentage
1	Main entrance	49.25
2	Ramp	36.35
3	Parking	0
4	Door	40
5	Corridor	60
6	Lift	32.93
7	Stair	32.74
8	Handrail	40
9	Toilet	12
10	Canteen	64
11	Drinking water	4
12	Signage	2.5
13	Emergency exit	0

3.3. Overall Accessibility Condition of Each Case Area

The overall accessibility percentage of each mall has been derived by calculating the percentage of all the parameters. After deriving the overall percentage of each case area, it is seen that the highest accessibility percentage is observed for Mani Square Mall, which was established in 2008, with 44.8%. The lowest percentage of accessibility, which is 14.4%,

is observed for Acropolis Mall, which was established in 2013. Figure 4 shows the mapping of the overall accessibility score of each case area. Table 3 shows the overall accessibility percentage of each case area.

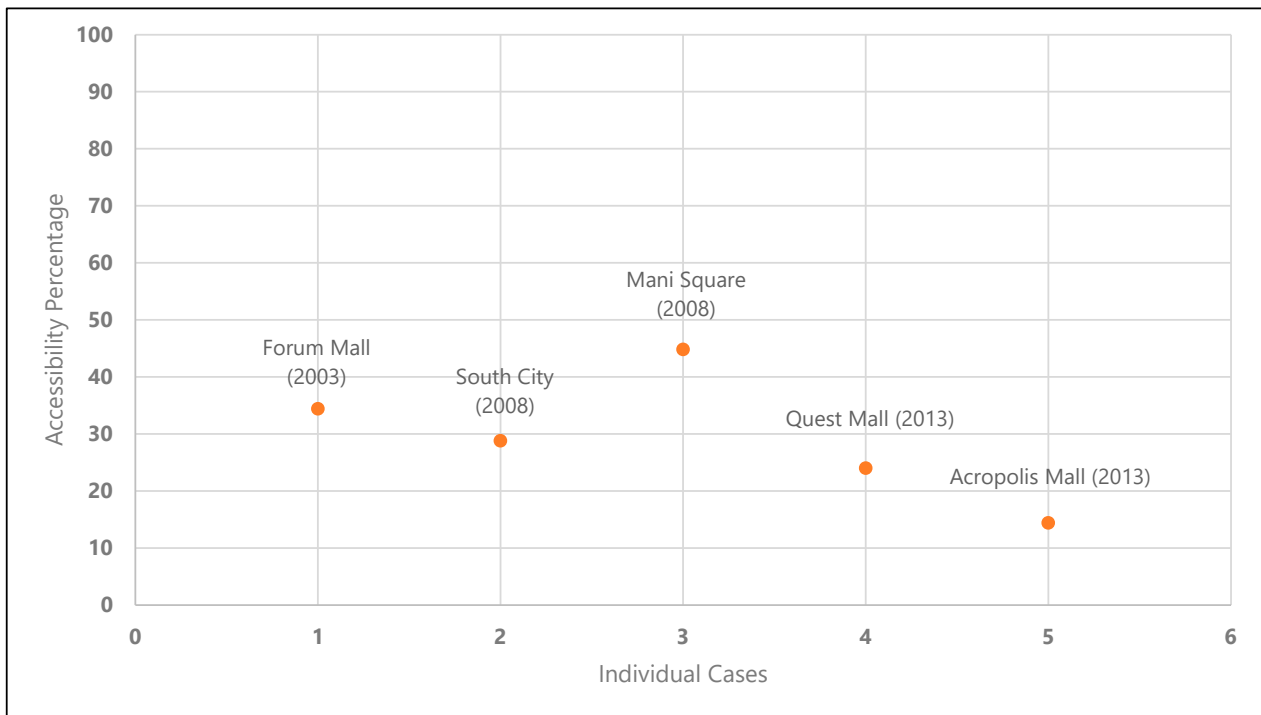


Figure 4. Graph showing the mapping of the overall accessibility percentage of each case area [Source: author].

Table 3. Table showing the overall accessibility percentage of each case area [Source: author].

Sl. No.	Case Area	Year of Establishment	Overall Accessibility Percentage
1	Forum mall	2003	34.4
2	South City mall	2008	28.8
3	Mani Square mall	2008	44.8
4	Quest mall	2013	24
5	Acropolis mall	2013	14.4

The correlation analysis is performed to relate the year of establishment of the case areas and the surveyed accessibility percentage of the selected case areas. The analysis is performed with the help of Pearson's correlation. For the correlation coefficient, the following formula (in Equation (1)) has been used, the subsequent data used in this exercise is mentioned in Table 4, and the correlation strength guide is elaborated in Table 5:

Table 4. The following table represents the data used in this exercise.

S. No.	x	y	x ²	y ²	xy
1	2003	34.40	4,012,009	1183.36	68,903.20
2	2008	28.80	4,032,064	829.44	57,830.40
3	2008	44.80	4032,064	2007.04	89,958.40
4	2013	24.00	4052,169	576.00	48,312.00
5	2013	14.40	4052,169	207.36	28,987.20
Sum	10,045	146.40	20,180,475	4803.20	293,991.20

Table 5. Table showing correlation strength guide.

Sl. No.	Range	Strength
1	−1.00 to −0.80	very strong negative
2	−0.80 to −0.60	strong negative
3	−0.60 to −0.40	moderate negative
4	−0.40 to −0.20	weak negative
5	−0.20 to ±0.00	very weak negative
6	±0.00 to +0.20	very weak positive
7	+0.20 to +0.40	weak positive
8	+0.40 to +0.60	moderate positive
9	+0.60 to +0.80	strong positive
10	+0.80 to +1.00	very strong positive

Equation (1): Calculating the correlation coefficient [sourced from Schober et al. (2018) [20]].

$$r_{xy} = [n\Sigma XY - \Sigma x\Sigma y] \div \sqrt{\{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]\}} \quad (1)$$

where

r_{xy} = correlation coefficient between x and y.

n = size of the sample.

ΣXY = summation of the product of x value times its corresponding y value.

Σx = summation of x value.

Σy = summation of y value.

Σx^2 = summation of each x value squared.

Σy^2 = summation of each y value squared.

Therefore,

$n = 5$.

$\Sigma xy = 293,991.2$.

$\Sigma x = 10,045$.

$\Sigma y = 146.4$.

$\Sigma x^2 = 20,180,475$.

$\Sigma y^2 = 4803.2$.

So,

$r_{xy} = [n\Sigma XY - \Sigma x\Sigma y] \div \sqrt{\{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]\}}$,

or $r_{xy} = [(5 \times 293,991.2) - (10,045 \times 146.4)] \div \sqrt{\{(5 \times 20,180,475) - (10,045)^2\} \times \{(5 \times 4803.2) - (146.4)^2\}}$,

or $r_{xy} = [1,469,956 - 1,470,588] \div \sqrt{\{[100,902,375 - 100,902,025] \times [24,016 - 21,432.96]\}}$,

or $r_{xy} = -632 \div \sqrt{\{350 \times 2583.04\}}$,

or $r_{xy} = -632 \div \sqrt{\{904,064\}}$,

or $r_{xy} = -632 \div 950.82$,

or $r_{xy} = -0.66$.

The correlation between the year of establishment of the case areas and their respective overall accessibility percentage is derived by calculating the correlation coefficient to understand the relationship between time and the accessibility percentage. The relation explains the implementation of accessibility in shopping malls over a period. The result of this correlation is -0.66 , which explains that it comes under a strong negative relationship. The strong negative relationship indicates that the accessibility of the shopping malls in Kolkata is decreasing over time.

Next, the correlation between the year of establishment of the case areas and the average accessibility percentage of each survey parameter for the entire survey is explained.

Here, the average percentage of accessibility has been derived from all the case areas and the correlation coefficient has been calculated to find out the relation between each parameter with time to understand where each of the parameters has improved with time in the shopping malls of Kolkata. For example, the correlation coefficient for the accessibility percentage of the door with year of establishment is -0.85 , which indicates a very strong negative relationship. This explains that accessibility for door parameters is decreasing with time. The correlation coefficient of the accessibility percentage of the signage parameter is 0.53 , which comes under a moderate positive relation, which explains that the accessibility percentage is increasing with time.

Table 6 represents the correlation coefficient between the overall accessibility percentage and the average accessibility percentage of each parameter throughout all the case areas. Figure 5 further shows the same information with the interpretation of the correlation coefficients.

Table 6. The correlation coefficient between the overall accessibility percentage and average accessibility percentage of each parameter throughout all case areas [Source: author].

Sl. No.	Variables	Correlation Coefficient
1	Overall accessibility %	-0.66
2	Accessibility % of main entrance	-0.79
3	Accessibility % of ramp	-0.80
4	Accessibility % of door	-0.85
5	Accessibility % of corridor	-0.68
6	Accessibility % of lift	0.15
7	Accessibility % of stair	-0.94
8	Accessibility % of handrail	-0.76
9	Accessibility % of toilet	-0.10
10	Accessibility % of canteen	-0.13
11	Accessibility % of drinking water	-0.13
12	Accessibility % of signage	0.53^*

* The strikingly positive correlation is related to the comparatively higher percentage of the presence of signage in one of the newest shopping malls, i.e., Quest Mall. In general, this aspect is completely absent in the other surveyed shopping malls.

3.4. User Group Study

The user group has been analyzed by referring to Goldsmith's 'Universal Design Pyramid' (Goldsmith, 2007) [21]. In Figure 6, the user groups are described as user groups from 1 to 8. User group 1 refers to fit, agile people, and user group 2 refers to the able-bodied people categorized under pointer A, who are considered to be the users who are focused upon by the architects. User group 3 is for able-bodied women, User group 4 is for elderly people with walking sticks and people with infants in pushchairs, and user group 5 is for ambulant people who have disabilities and visually impaired people. The user groups from 1 to 5 are categorized under pointer B, which is described as users who could, when new buildings are designed, be conveniently accommodated by the suitable normal provision, but often are not. User group 6 encompasses independent wheelchair users and user groups 1 to 6 are categorized under pointer C, which is described as users whose needs may not be entirely taken care of when they use buildings. User group 7 encompasses the people in wheelchairs who require additional assistance and specially-abled people who drive electric scooters, and user group 8 refers to the wheelchair users who need two people's assistance. User groups from 1 to 8 are categorized under pointer D, which is described as the ideal situation.

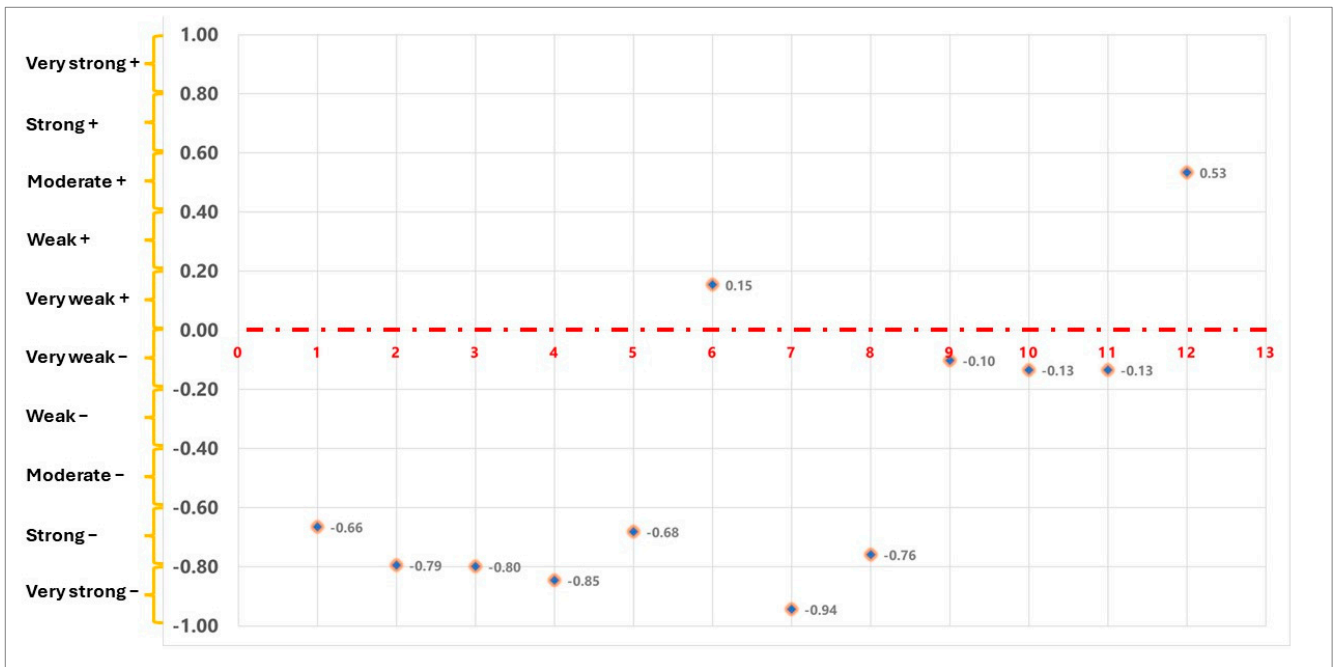


Figure 5. A mapping of the overall accessibility percentage and average accessibility percentage of each parameter with the year of establishment [Source: author].

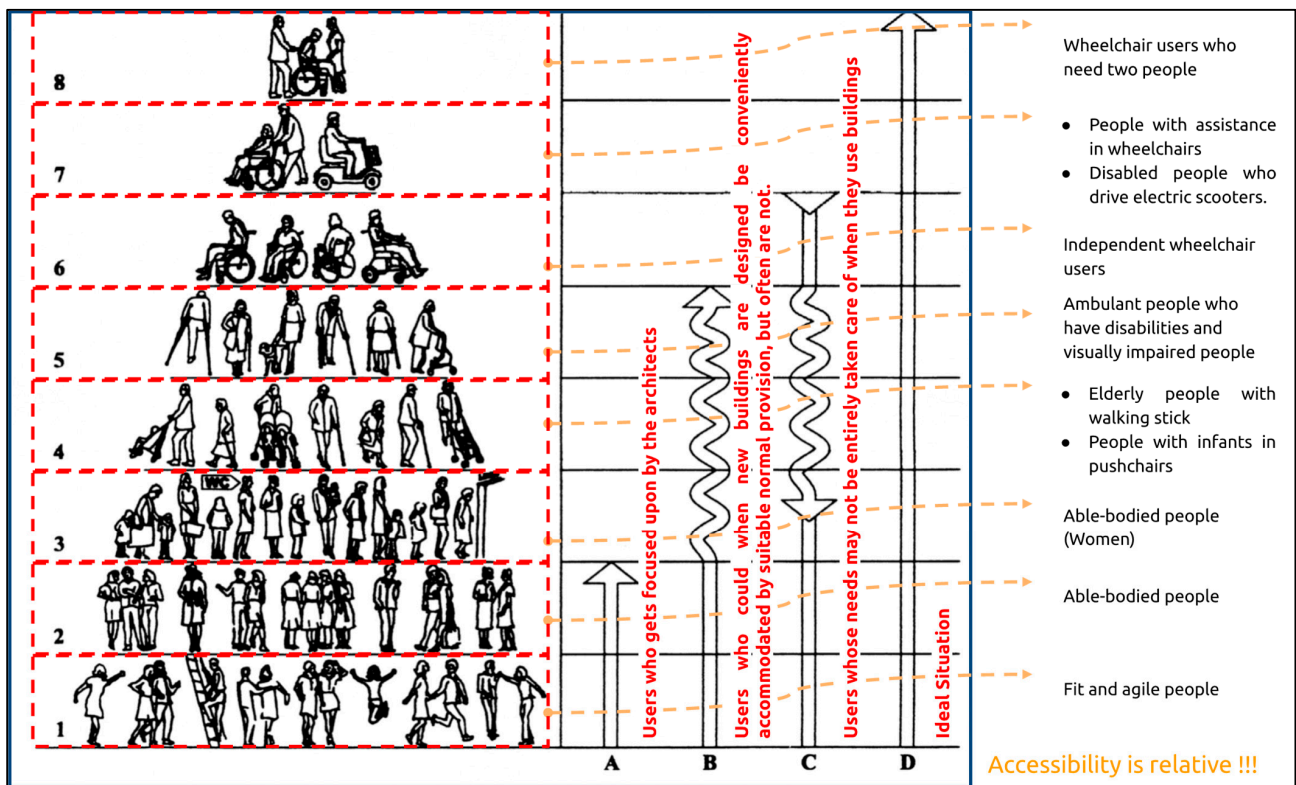


Figure 6. Universal design pyramid [source: adopted from Goldsmith, 2007] [21].

3.4.1. Mapping the Relative Accessibility Percentage for All Shopping Malls across Different User Groups

This segment describes the first stage of user group analysis by mapping the relative accessibility percentage of each user group concerning each case area. The relative accessibility is derived by considering the presence or absence of any indicator in respective case

areas with each user group. In this process, each user group has been considered for each of the indicators individually. The data have been entered as if with the absence of any indicator. If any user group is unaffected then it receives a score of 1, and if any user group is affected then its score is 0. For example, with the absence of a ramp, user group 4 (elderly people with walking sticks; people with infants in pushchairs), user group 5 (ambulant people who have disabilities and visually impaired people), user group 6 (independent wheelchair users), user group 7 (wheelchair users who require assistance and people who drive electric scooters), and user group 8 (wheelchair users with two assistants) are effected, so the score becomes 0, whereas user group 1 (fit and agile people), user group 2 (able-bodied people), and user group 3 (able-bodied people and women) are not affected, so their score becomes one for this particular indicator. In this manner, all the user groups for each indicator are analyzed and the percentage is derived. Figure 7 explains the mapping of the relative accessibility percentage for each user group for each case area (here, user groups 1 and 2 are considered together because their situations are similar). The graph in Figure 7 shows that user group 6, i.e., independent wheelchair users, have a minimum percentage of accessibility compared to other user groups in all case areas.

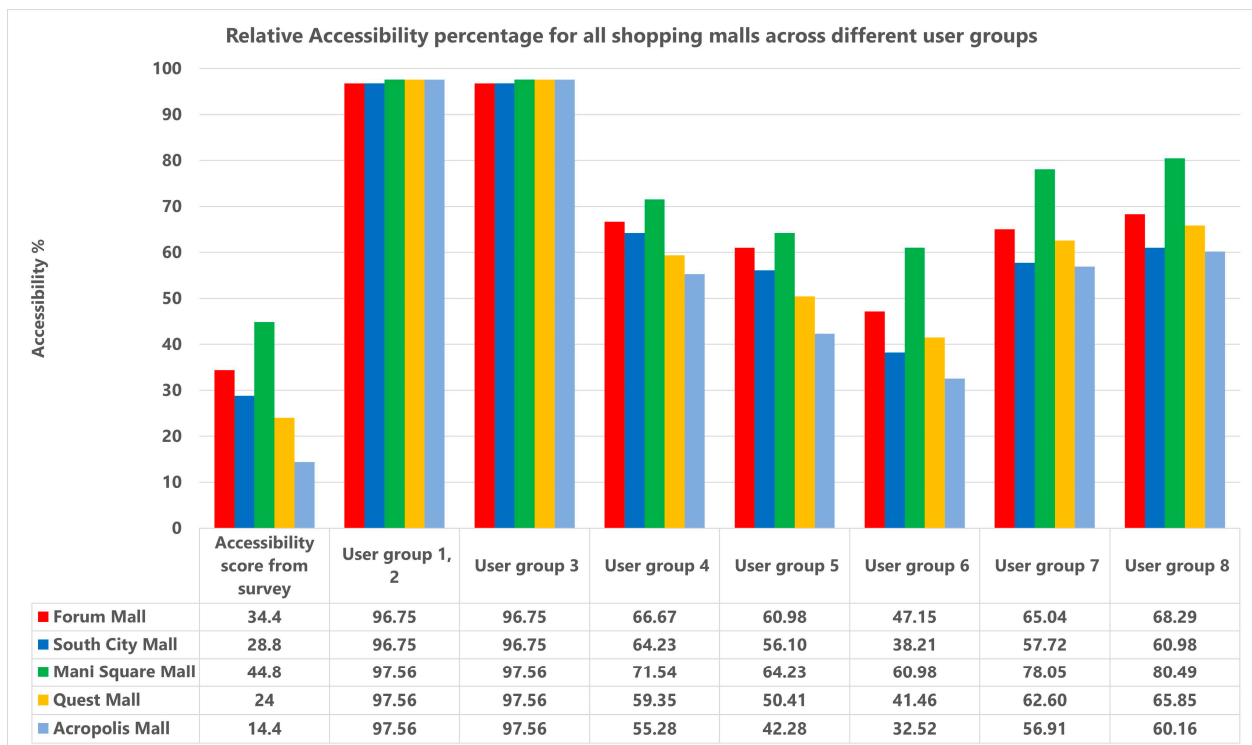


Figure 7. Graph showing the mapping of the relative accessibility percentage of user groups across each case area [Source: author].

3.4.2. Mapping the Average Accessibility Percentage of Each Parameter across Each User Group

This paragraph describes the second step of user group analysis. This section includes the mapping of the average accessibility percentage of each parameter across each user group. Here, we present the average accessibility percentage for each user group for each of the parameters across all case areas. The average percentage of accessibility for the emergency exit parameter is 0% for all user groups from 1 to 8, which explains that the absence of the indicator under the emergency exit parameter does affect all the user groups, so the average percentage of accessibility is 0. For the parking parameter, the average percentage for user groups 1 to 5 is 100% and for users 6 to 8 it is 0%. Figure 8 shows the mapping of the average accessibility percentage of each parameter across each user group.

3.5. Spatial Interpretation of the Case Areas

The spatial interpretation of the case areas has been performed to clarify the relationship parameters have with each other and to understand the difficulties faced by a user from the start to the end of their path. To understand this phenomenon, a diagram titled 'Flowchart showing the accessible route' (Figure 9) has been made. Figure 9 explains the accessible route, which consists of the spatial parameters (other than the door, handrail, and signage parameters). Here, three origins of the path are considered: parking (which comes under parameters), portico, and approach road. The origins are determined by thinking about the possible mode of transport to respective malls to understand the start points for users, where (1) origin 1—parking: entrance by a personal vehicle which will be parked in the parking area; (2) origin 2—portico: mode of transport includes a personal 4 wheeler or a taxi which will drop the user off in the portico, where the first step to enter the building is through the main entrance door; and (3) origin 3—approach road (not considered as a parameter): transportation, in this case, could be any form of public transport, taxi, any other mode of transportation in which the drop-off takes place on the approach road outside the mall premises. The second step to the accessible route is the path which is divided into two parts (1) horizontal, which includes the corridor; and (2) vertical, which includes the ramp, stairs, and lifts. The third step is the destination for the accessible route, which includes the spaces included under the parameters under consideration, such as the canteen, toilet, drinking water, and emergency exit. The other major spaces of the malls, such as retail spaces, multiplexes, and any other spaces for entertainment could be reached through the door (which comes under parameters).

Based on the origin–path–destination, this part of the analysis is completed (1) to understand the relationship between parameters in case areas and (2) to understand the circulation in the case areas concerning user groups and their movement from origin to destination. The interpretation is conducted according to the following process:

1. The ground floor plans of the case areas are digitalized to understand the relation of the spatial parameters with each other.
2. Three-floor maps have been digitalized for the accessible route to understand the accessible continuity in the case areas.
3. Each case area has four maps:
 - A ground floor plan showing all major spaces on the ground floor of the building with the nomenclatures.
 - Floor map 1 represents the route, considering the entry points to the ground floor of the building when the origin is parking. Refer to Table 5 for a description of the legends used in the floor maps.
 - Floor map 2 represents the route, considering the origin point as the portico of the ground floor. Refer to Table 5 for a description of the legends used in the floor maps.
 - Floor map 3 represents the route, considering the entry points when the approach road is the origin. Refer to Table 7 for a description of legends used in the floor maps.
4. The floor maps represent the accessible route and the user group with the least accessible percentage of the parameters present on the ground floor of the case areas.
5. In this section, the parameters that are mentioned as part of the accessible route are represented on the floor maps.
6. The parameters such as handrails and signage, which are non-spatial, are not represented in the floor maps.
7. The parameter emergency exit has 0% accessibility in all the case areas, so it is not represented in the floor maps.

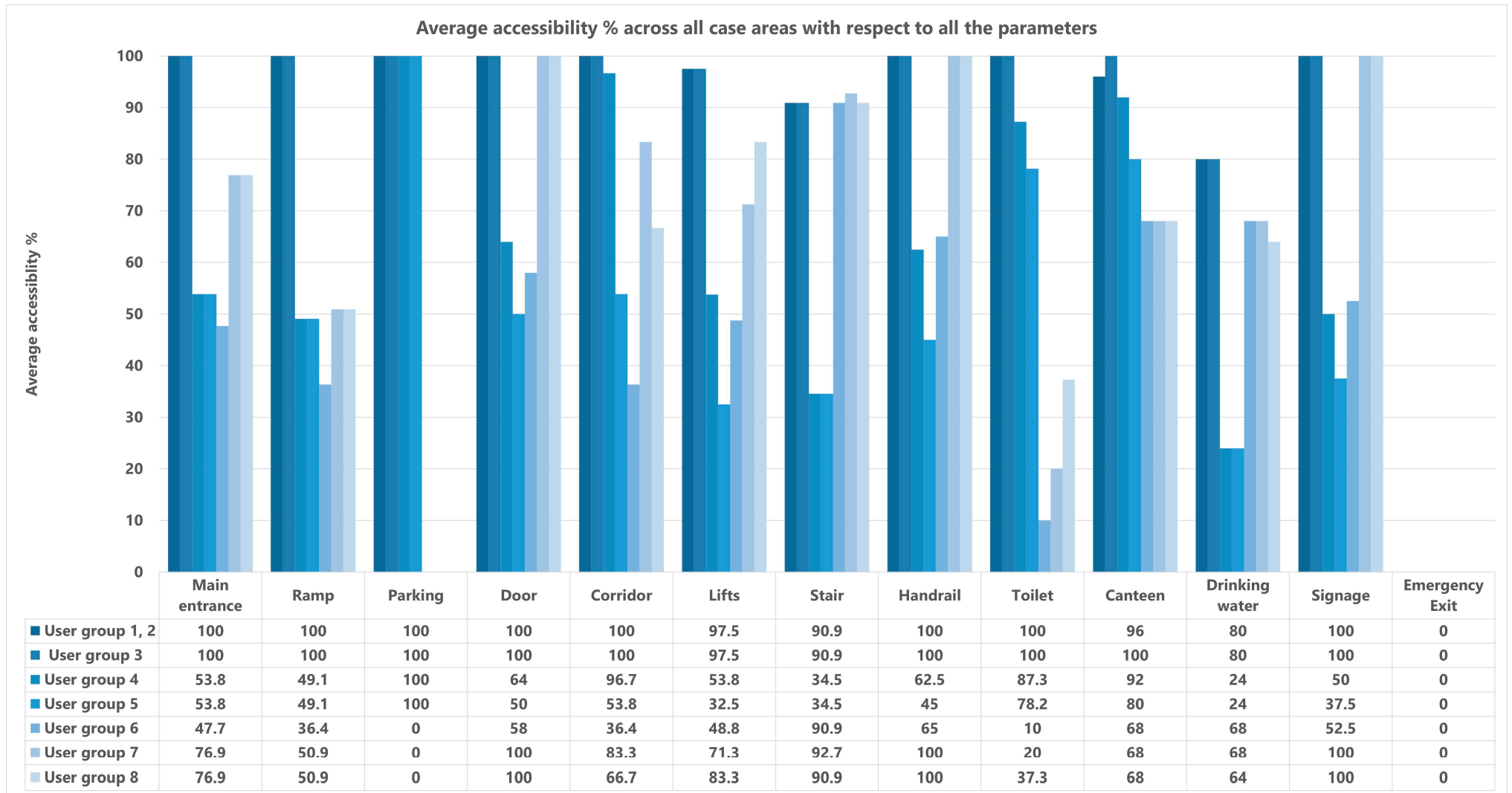


Figure 8. Graph showing the average accessibility percentage of each parameter across each user group [Source: author].

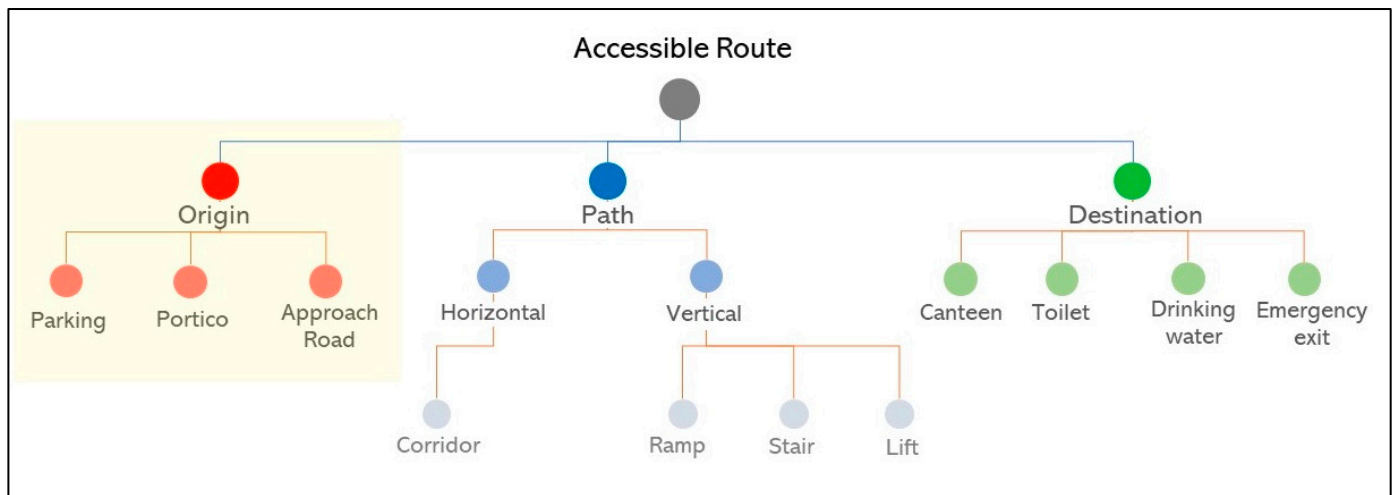


Figure 9. Flow chart showing the accessible route [Source: author].

Table 7. Table showing the legends and their descriptions for the floor maps [Source: author].

Legend	Description
	Origin
	Retail Space
	Stair
	Lift
	Corridor
	Door
	Toilet
	Parking
	Ramp
	Drinking water

3.5.1. South City Mall

South City Mall is a part of a gated community in which the mall is located at the entrance of the complex alongside the approach road (Prince Anwar Shah Road). The entrance to the mall is from the front side of the mall only. There is one entry and one exit to the mall. The parking of the mall is in the basement as well as in the multi-level car parking area at the rear side of the mall. The pedestrian entrance to the mall is from the front side of the mall from the approach road. Pedestrians can enter from four points: two points at the vehicular gate and two stepped entries adjacent to the approach road. The portico is situated at level +900 mm. The atrium of the mall is oval-shaped. The central atrium consists of small retail spaces and a parallel corridor with an entrance to the anchor stores. The east, west, and north sides of the mall have three anchor retail spaces. The ground floor of the mall consists of eight staircases, six lifts, and two toilets each for males and females, which includes accessible toilets, and one drinking water facility. Figure 10 is the ground floor plan for South City Mall.

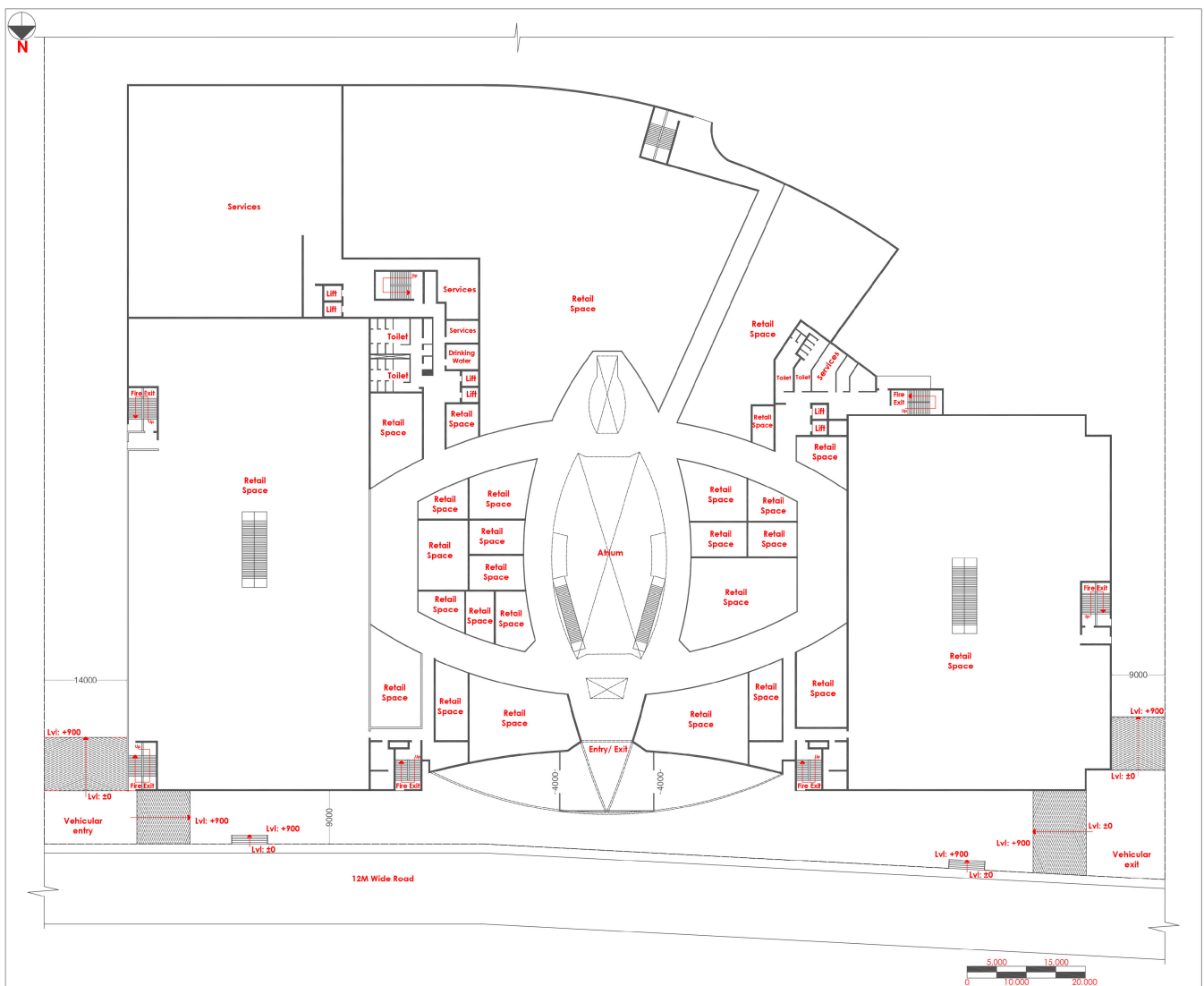


Figure 10. Ground floor plan of South City Mall [Source: author].

Origin 1—Parking: When the origin of movement (marked with red arrows to explain the flow of circulation from the origin to other spaces of the mall in Figure 11) for users is parking, these users enter the ground floor of the mall via the staircase and lifts, which are connected to the basement. All the lifts on the ground floor are connected to the basement and two staircases. There is a total of five entry points from the basement parking to the ground floor. The entry point stairwell has the lowest accessibility percentage (45.45%) for user groups 4 and 5 and for the lift, user group 5 has the lowest percentage: 31.25%. The entry points relate to corridors to the atrium of the mall. Corridors have the lowest percentage of 83.33% for user groups 5, 6, and 7. The corridors connect to the toilets and drinking water facilities. The toilet has 0% accessibility for user group 6, which is the least-served user group, and the drinking water has 20% accessibility for user groups 4, 5, and 6, making it the least-served accessibility parameter. The retail spaces can be entered through the doors, which are considered as a parameter in the research. The door has 50% accessibility for user groups 4, 5, and 6 as the least-served user group. The floor map (Figure 11) shows the connectivity of spaces with the least-served user group accessibility percentage. The movement around the mall is marked with red arrows considering parking as the origin, and when parking is considered the entry to the ground floor from the basement parking is through lift or staircase. So, the starting point is considered as lift and staircases.

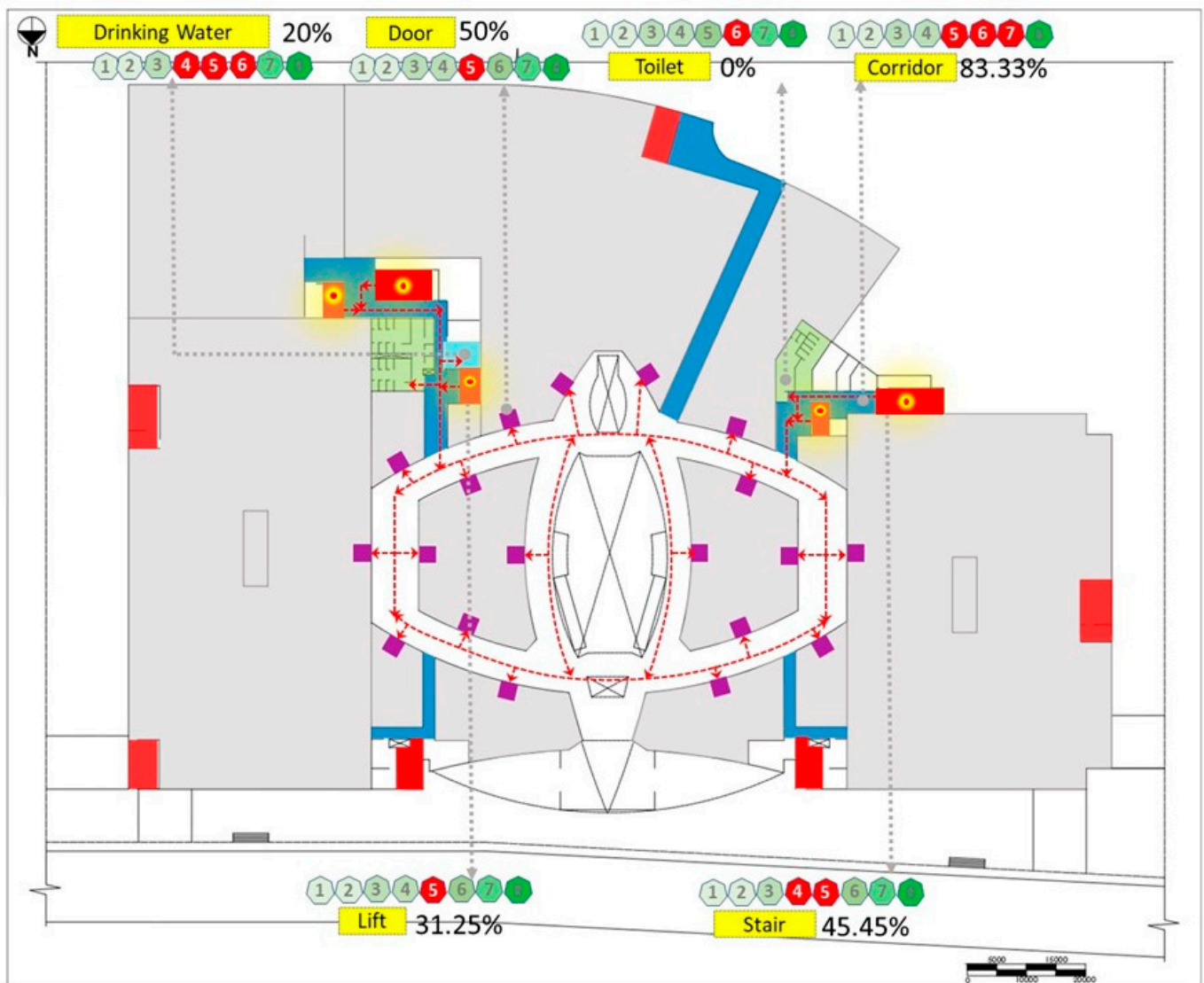


Figure 11. Ground floor map of South City Mall showing the accessible route when the origin is parking [Source: author].

Origin 2—Portico: When the portico is considered as the origin, the starting point for entering the mall remains the portico. When the start point is the portico then the entrance to the mall is through the entrance door, which is 50% accessible for user group 5 as the minimum-served group. The movement remains the corridor, which is 83.33% accessible for user groups 5, 6, and 7. Then, the entry to the destinations such as retail space doors is 50% accessible for user group 5, the toilet is 0% accessible for user group 6, and drinking water is 20% accessible for user groups 4, 5, and 6. For users wishing to reach the first to the fifth floors and the basement floors, the lift and staircase are considered as options for vertical movement. The lift has 31.25% accessibility for user group 5, while the accessibility percentage for the stairs is 45.45% for user groups 4 and 5. Figure 12 shows the ground floor map of South City Mall showing the accessible route when the origin is the portico. The movement around the mall is marked with red arrows considering portico as the origin).

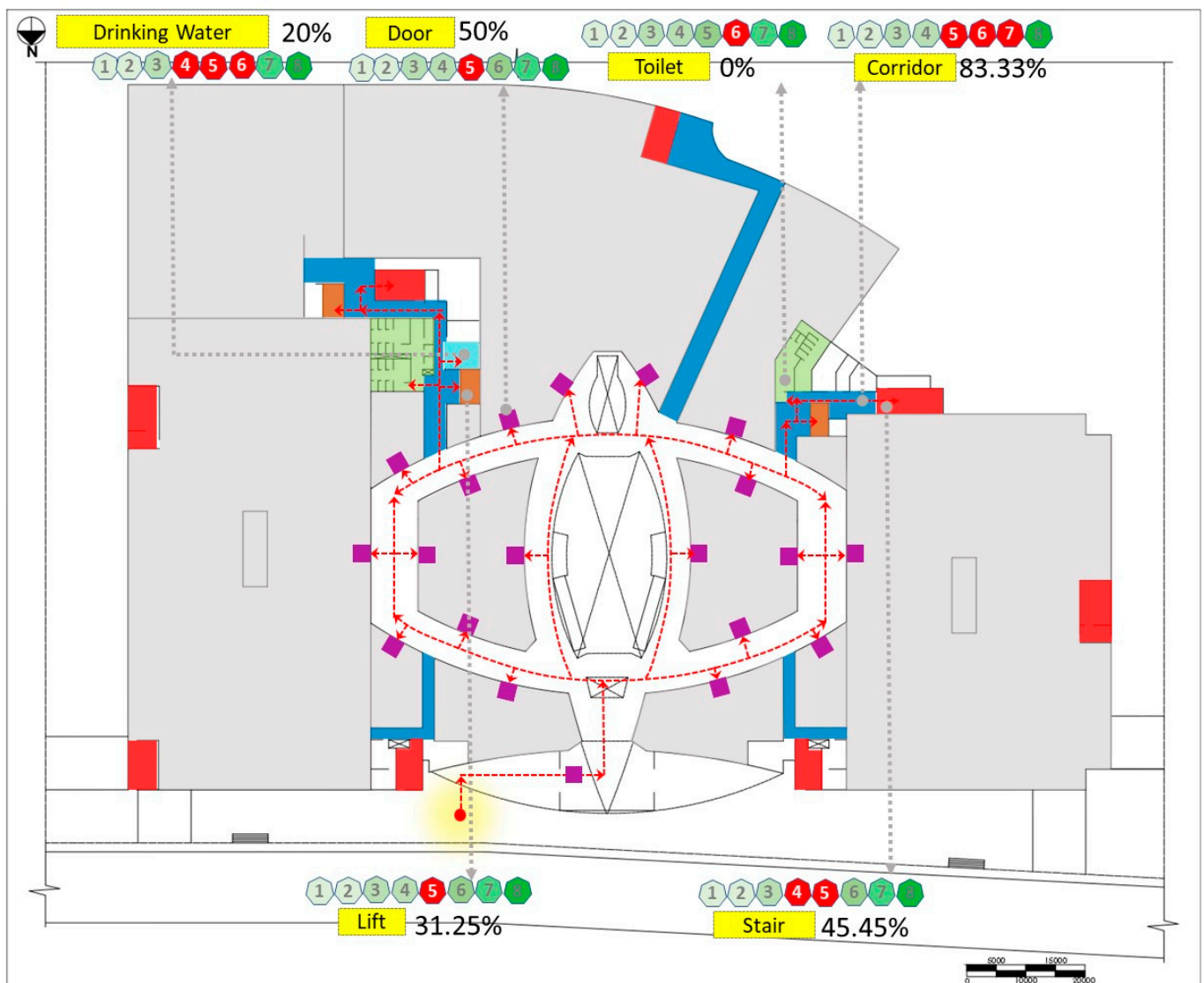


Figure 12. Ground floor map of South City Mall showing accessible route when the origin is the portico [Source: author].

Origin 3—Approach Road: When the origin is the approach road, it means that the users are starting from the road outside the mall when attempting to enter the mall. In this case, the main entrance is the entry point to the building. The main entrance to the mall is 61.54% accessible for user groups 4, 5, and 6, which is the lowest percentage. With the main entrance, a ramp as a parameter is also another way to enter the building, which is 54.55% accessible for user groups 4, 5, and 6. After that, the route is similar to that of origin 2, i.e., the portico. The diagram (Figure 13) represents the floor map showing the route map when the approach road is considered to be the origin. The movement around the mall is marked with red arrows considering approach road as the origin.

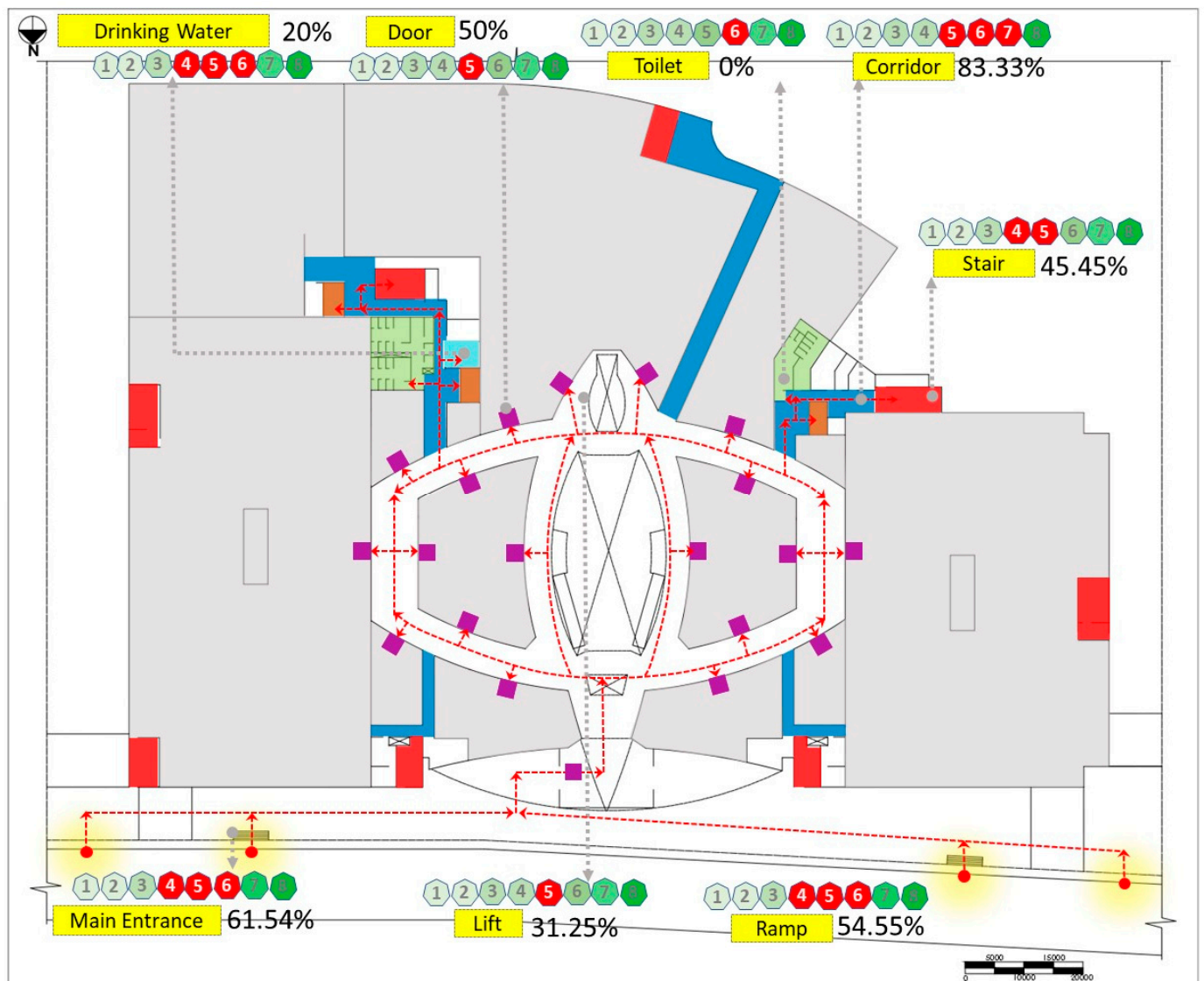


Figure 13. Ground floor map of South City Mall showing accessible route when the origin is the approach road [Source: author].

3.5.2. Mani Square Mall

Mani Square Mall is adjacent to the E M bypass road. The abutting road to E M bypass road is the approach road for the mall. The mall has one vehicular entry and one exit. The pedestrian entrance to the mall is a pedestrian path adjacent to the vehicular road which has a level difference from the vehicular road. The pedestrian entrance is accessible from both vehicular entries as well as the exit to the mall premises. The portico is at +900 level. The mall has five floors, two basements, and multi-level car parking. On the ground floor of the mall there are four stairs, seven lifts, and one toilet space each for males and females.

Origin 1—Parking: The mall has two basements and one multi-level car parking area at the rear side of the mall. The multi-level parking area is connected to the basement of the mall. When parking is considered as the origin of the accessible route then the entry to the ground floor from the basement occurs via the lifts (vertical movement) and stairs (vertical movement). For the lift, the least-served user group is 5, with 43.75% accessibility, and for the stairs, the least served user groups are 4 and 5 with 36.36% accessibility. In order to reach the other spaces from the start point of the floor, the next step will be the corridor (horizontal movement), where the least-served user group is group 5, with 66.67%

accessibility. The destinations such as toilets and doors to the retail spaces have accessibility percentages of 45.45% (for user group 6) and 50% (for user group 5).

Origin 2—Portico: When the portico is the point of origin for the users to enter the mall, the first step is a ramp and a stairway. The ramp has 72.73% accessibility for user group 6 and the stairway has 36.36% accessibility for user groups 4, and 5, as the least-served groups. The next point is the entrance door, which is 50% accessible for user group 5. For movement, the corridor has 66.67% accessibility for user group 5. The destination toilet has 45.45% accessibility for user group 6, as the least-served group. To reach other floors, the vertical movement takes place via the stairs and lift. Stairs have 36.36% accessibility for user groups 4 and 5 and the lift has 43.75% accessibility for user group 5 as the least-served group.

Origin 3—approach road: When the approach road is the origin of the mall, the start point is the approach road, and the first step is the main entrance, which is 61.54% accessible for user groups 4, 5, and 6 as the least-served groups. The next step is the ramp to the entrance as discussed for origin 2, which is the portico. All the next steps for the accessible route of the mall are the same as those listed for origin 3.

3.5.3. Quest Mall

The Quest Mall has roads on three sides of the mall, but the main entrance is via Syed Amir Ali Avenue. The mall has two vehicular entry points and two exits. There are two steep pedestrian entries on the front side of the building. The mall has five floors, two basements, and one multi-level car park attached to the mall at the rear side of the mall. The portico is at +900 mm level. There are three entries and exits to the building, one from the front, one from the back, and one from the multi-level car parking area. There are four stairs, six lifts, and one toilet each for men and women.

Origin 1—Parking: For Quest Mall, when the origin is parking, the entry to the ground floor is through the stairs, the lift from the basement parking area, and the multi-level car parking area. When the entry is from the multi-level parking area, the step is through a corridor (horizontal movement), which is 83.33% accessible for user groups 6, 7, and 8. The entry through the lift (vertical movement) is 50% accessible for user group 5 and for the stairs (vertical movement) it is 27.27% accessible which for user groups 4 and 5. The entrance doors to retail spaces are 30% accessible for user group 5. The destination toilet has 4.55% accessibility for user group 5.

Origin 2—Portico: When the origin of the mall is the portico, the first step of the accessible route is through the main door, which is 30% accessible for user group 5, the least-served group. Horizontal movement in the mall takes place through the corridor, which is 83.33% accessible for user groups 6, 7, and 8 as the least-served groups. For vertical movement, the stair is 27.27% accessible for user groups 4 and 5 and for the lift, the least-served user group is group 5, for which there is 50% accessibility. The destination toilet has 4.55% accessibility for user group 6 as the least-served group.

Origin 3—approach road: When the origin is the approach road, the first step to the accessible route is the main entrance and the ramp. The main entrance parameter is 38.46% accessible for user groups 4, 5, and 6 and the ramp is 0% accessible for user group 6 as the least-served group. The next step is the entrance door, which is 30% accessible for user group 5 as the least-served group. The next steps to the accessible route for origin 3 are the same as those described for origin 2.

3.5.4. Acropolis Mall

The Acropolis Mall has roads on three sides of the mall. The main approach road is the Rajdanga main road. The vehicular entry and exit to the mall are from three sides of the mall. The pedestrian-stepped entry is from the three sides of the mall. The portico is at +1050 mm level. The portico can be reached by the steps or the slope for vehicular movement. There are two main entrances to the mall from two different sides of the mall. The mall has five floors and three basements. The ground floor has five lifts and four stairs. The ground floor of Acropolis Mall does not have any toilet facility.

Origin 1—Parking: When the origin is parking for the Acropolis Mall, the entry to the ground floor is through the stairs and lift because the parking area is in the basement. So, with the help of the vertical movement lift and stairs, the entry to the mall can be accessed for users whose origin is parking. The lift has 12.5% accessibility for user group 5 and for the stairs, the lowest percentage is 18.18% for user groups 4 and 5. The lift and stairs from the basement open into the corridor for horizontal movement, which is 66.7% accessible for user groups 6, 7, and 8 as the least-served groups. To enter the retail spaces, the door has 50% accessibility for user group 5 as the least-served group.

Origin 2—Portico: When the portico is considered as the origin of the accessible route then the first step to enter the mall is through the main door, which is 50% accessible for user group 5 as the least-served group. For horizontal movement in the mall, the corridor has 66.7% accessibility for user groups 6, 7, and 8; for vertical movement, the lift has 12.5% accessibility for user group 5; and the accessibility is 18.18% for the stairs, affecting user groups 4 and 5 as the least-served groups.

Origin 3—Approach Road: When approach road is considered as the origin of the accessible route for the ground floor of the mall then the first step to enter the mall is the main entrance with 30.77% for user group 6 as the least served and the ramp is 0% for the user group 6 as the least-served group. The next step is the main entrance door, and the rest of the accessible route is the same as the origin 2 of the mall.

4. Discussion

Comparative analysis of all case areas is performed concerning the accessible route across user groups. This analysis is performed to understand the differences and similarities of the missing accessibility features in the accessible route throughout all case areas. This analysis is performed considering all user groups but points out the least-served user groups based on the accessibility features across all case areas. This analysis is conducted in the following order:

1. The idea of the analysis is generated by the accessible route of all user groups across all case areas [accessible route: origin–movement–destination].
2. After fixing the accessible route, the accessibility % calculation for each of the user groups in each of the parameters is performed and the user group with the lowest accessibility percentage in each mall is determined. (N.B.: *Here, we are considering the least % so that if we can deal with the lowest percentage then we will be able to serve all the user groups).
3. In this analysis, the following conclusions have been noted:
 - Different accessibility conditions were observed for the origin, movement, and destination.
 - Similarity in the weak accessibility segments among the case areas. Example: For Parking, it is the same for all malls, i.e., User group 6, 7, 8 which has 0% accessibility, which clearly states that the features in the parking areas do not support users in wheelchairs both with and without assistance.

The comparative analysis has been represented as a graph in Figure 14. The graph represents a comparative analysis of the total accessibility percentage as opposed to the lowest accessibility percentage among all user groups. The graph represents the dissimilarity between the overall accessibility percentage with the origin, movement, and destination when the user groups are considered.

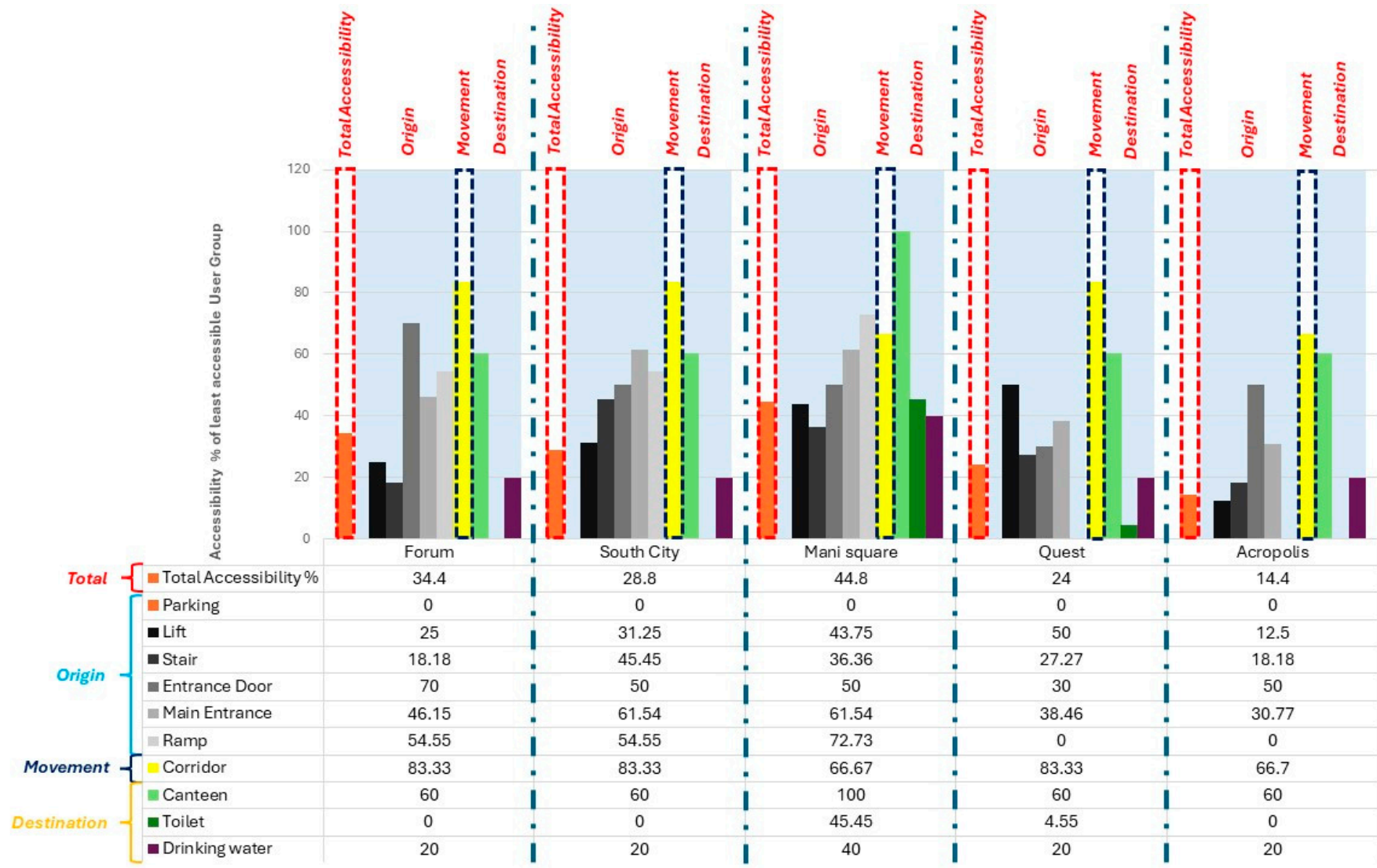


Figure 14. Dissimilarity between the overall accessibility percentage [Source: author].

Thus, we can see that the ideal accessibility situation in shopping malls is far from reality in the case area. Even multiple previous studies proved that universal design is an ignored phenomenon in shopping malls in the Indian context [22]. Convenience in different forms like movement or infrastructure has been identified as an important reason for customers returning to a shopping mall [23]. Bodzemir and Dikmen (2021) have listed the major parameters used for evaluating universal design in shopping malls as (a) location, (b) transportation, (c) entrance and direction, (d) information desk, (e) information and direction signs, (f) circulation elements, (g) toilets, and (h) a baby care room [24]. Among all other parameters, prioritization of entrance, movement patterns, and signage as the starting point of universal design analysis is beneficial for a diverse user group [25,26]. Abdullah and Jian (2020) state that a contextual research methodology can be adopted due to the lack of adequate techniques for interpreting universal design at shopping malls. Furthermore, they identify the following parameters for assessment of universal design: (a) stairs, (b) ramps, (c) escalators, (d) path of travel, (e) hallways, (f) elevators, (g) escalators, (h) doors' appearance, (i) maneuvering space, (j) architectural wayfinding, (k) graphical wayfinding, (l) service desks, (m) waiting areas, and (n) restrooms [27]. Adewale et al. (2022) explain the importance of perceptible information in the design of shopping malls [28]. Global studies are more focused on catering to the needs of disabled people rather than considering facilitating the needs of all user groups by considering universal design considerations [29]. Abdallah and Jian (2019) consider usability, safety, and comfort in the quantitative analysis of universal design in shopping malls [30]. More specifically, planning the means of escape in shopping malls, including alignment with building code, emergency evacuation, manual call points, alarms, and fire safety signage, is of utmost importance. Likewise, a case-specific or contextual understanding of universal design is better suited for retrofitting or retrofitting existing shopping malls in urban areas [31].

5. Conclusions

First, our research objectives are revisited and elaborated hereafter. One objective of this paper was to understand the condition of universal design in shopping malls in Kolkata, India. The aforementioned condition has been interpreted with the sequence of data collection and data analysis. The overall condition is understood by the derived overall accessibility percentage of each case area and the correlations which reflect a strong negative relation between the year of establishment and the accessibility percentages. Another objective of the research was to evaluate the extent of universal design possible in existing shopping malls in Kolkata. This objective has been fulfilled by analyzing the accessible continuity with the help of the accessible route analysis and understanding the gaps in the accessible continuity in each case area. The last objective was to provide recommendations for the improvement of universal design features in shopping malls in Kolkata. The recommendations have been provided based on whether a specific parameter needs (a) building (new construction), (b) retrofitting (constructional upgrading), (c) operating (mobilizing a parameter with minimum intervention), or maintaining (taking due care of existing infrastructure) depending on the user group with the lowest accessibility percentage for each parameter in each case area.

Second, we have attempted to answer the research questions posed at the beginning of the paper. The answer to the first research question (How accessible are the shopping malls in Kolkata?) has been derived from a sequence of analyses which indicated that the shopping malls in Kolkata, India, do not comply with the universal design features to a satisfactory level. The second research question asks what design possibilities could be implemented to make shopping malls more accessible. The proposals for design possibilities highlight that most of the parameters in overall case areas must be built from scratch, but this depends on the individual case areas according to the provisions in the respective case areas.

Third, the huge impact of the limitations on the research is explained. The first limitation states that the case area selection took place only within the Kolkata Municipal Corporation (KMC) boundaries. The KMC has the maximum number of shopping malls as compared to Bidhannagar Municipal Corporation and Kolkata Metropolitan Development Authority, which helped when we were selecting the case areas from different wards. KMC is densely populated, and its shopping malls also have higher collective footfall than shopping malls from other corporations. The second limitation was that movement-based disability should be prioritized. The focus on movement-based disability has meant that the research focused on one specific direction and came up with a process to understand the gaps in the accessible continuity of the case areas. A similar process could be applied to deal with other types of disabilities.

Fourth, the academic benefit of this research is briefly stated. Since this paper has been conducted to understand the universal design scenario in the shopping malls of Kolkata, India, the completion of this paper is likely to benefit the design fraternity to understand the situation of the accessible continuity in shopping malls. This paper will further help the design fraternity to understand the gaps in accessible routes for diverse user groups and the gaps in accessible continuity while designing/ redeveloping any shopping malls in Kolkata. Most importantly, this research is a humble step towards ensuring inclusive public spaces and thereby moving closer to the global drive towards sustainable cities and communities.

Finally, to conclude, the hypothesis considered in this paper states that the shopping malls in Kolkata have inadequate universal design features. The hypothesis has been proven right in the process of the research with the help of (a) the analysis of the parameters in each of the case areas, which were derived to be below a satisfactory level, and (b) finding the gap in the accessible continuity by analyzing the accessible route gaps for each of the parameters.

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