Does Relative Accessibility to Service Facilities Impact Residents' Satisfaction? Socio-Spatial Analysis to Determine Deprivation and Location Attachment.

Abu-Baker Rafat KHAN[*1], Tomohiko YOSHIDA[*2]

Abstract: Access to urban facilities from residential locations has become a hot topic. Developing countries such as Pakistan have built housing schemes on a large scale for low-income people at locations with low proximity to service facilities. Empirical studies about the access capacity of urbanites to service facilities are also few in number. Taking Rawalpindi-Islamabad Metropolitan Area (RIMA), this study compares the spatial access to five service facilities between city core, mid-urban and suburban residents by measuring the distance from the residential parcel to each facility. A total of 435 samples were collected from nine study sites across RIMA.

Both spatial accessibility analysis and statistical analysis of household access satisfaction were employed in this study. Spatial analysis showed significant discrepancies in access to low-order and high-order service facilities across RIMA. The household survey from nine study sites recorded access satisfaction to service facilities, degree of location attachment, satisfaction with the built environment, and the desire to live near a Bus Rapid Transport system BRT. The findings concluded that the provision of necessary service facilities should be considered when planning to establish affordable housing for low-income people.

***Keywords**: Accessibility, deprivation, Rawalpindi-Islamabad, service facilities, spatial pattern.*

(1) Introduction

The Department of Economic and Social Affairs of the United Nations published "World Urbanization Prospects 2019," which detailed the rapid urbanization amongst the less and least developing nations over the past three decades (UN, 2021). Cities around the globe are now competing to provide enough resources, such as services, facilities, and infrastructure, to enhance their residents' quality of life (Jung et al., 2015). Zeng et al. (2019) argued that affordable housing for disadvantaged groups is essential as it is a fundamental element of the global housing development systems. For instance, Ibem (2013) stated that providing clean water, sanitation, electricity, and social infrastructure is key to building a healthy human settlement with an appropriate living environment. Such infrastructure development

*1 Doctoral student, Graduate School of Policy Sciences, Ritsumeikan University
*2 Professor, College of Policy Sciences, Ritsumeikan University

E-mail:
*1 ps0205hv@ed.ritsumei.ac.jp
*2 tyoshida@sps.ritsumei.ac.jp

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should meet residents' demands to foster citizens' connections to the services and the overall community. However, for these large-scale developments to succeed, a guaranteed, large number of regular users is critical. Mulley and Moutou (2015) cautioned that large-scale investments for developing service facilities sometimes fail to achieve their goals because such facilities cannot find regular users.

City planners traditionally locate affordable housing in the urban fringes, which can cause various social issues such as isolated low-income neighborhoods and poor access to service facilities (Woo and Kim, 2016). Local developers often fail to ensure better access to service facilities when establishing affordable housing, as seen in China (Ma et al., 2018; Yang et al., 2014), Chile (Martinez et al., 2018), Nigeria (Ibem, 2013), and United States (Woo and Kim, 2016). Though several studies spatially analyzed poor access to service facilities around affordable housing locations, they have targeted only one facility, such as health, food, or recreational facilities, in one case study. Therefore, a substantial examination of the access capacity to several local service facilities to identify the effect of accessibility deprivation on the quality of life demands extensive exploration. Also, it is essential to identify the target population living in different geographical locations. Zeng et al. (2019) examined the accessibility deprivation amongst Affordable Housing Communities in Nanjing, China, using spatial and statistical analyses. Another study focused on household surveys in social housing units (Norris and Hearne, 2016). To date, however, no study targets the residential areas near the city core and mid-urban and suburban regions to understand the accessibility deprivation in various geographical locations. Thus, this study takes the case of the Rawalpindi-Islamabad Metropolitan Area (RIMA), which fills the gap by spatially analyzing the city-wide accessibility to multiple service facilities and statistically comparing the access satisfaction of mixed-income groups.

Besides developing affordable housing projects for disadvantaged groups, city planners face difficulties in increasing service facility usage. Failure to upgrade the old city technologies might cause complications in implementing the infrastructure of citizens' choice (Angelidou, 2014). This hindrance could be due to residents who might consider accessing services like public transportation (PT) as unsafe, inconvenient, and time-consuming (Mulley and Moutou, 2015), the cities' sprawl associated with low-density neighborhoods might cause low or no access to essential service facilities, leading to long travel time and shifting to private vehicles (Mattingly and Morrissey, 2014). Therefore, Mulley and Moutou (2015) insisted that local city planners regularly encourage residents to utilize service facilities. This regular use of the neighborhood facilities can ensure attachment to the community, resulting in a good long-term relationship because residents care about their current location and have established a close bond with the environment surrounding their residence (Casakin et al., 2015). Though existing studies have attempted to understand the degree of city attachment amongst residents empirically, their results are usually based on sociological and psychological models that neglect the concept of city and regional policy processing. To optimally increase service facility usage, it is essential to analyze household preferences, household dynamics, and degree of location attachment. However, previous service management studies usually focused on the performance and quality of the urban facilities, ignoring the residents' attitudes towards access satisfaction and travel behavior.

This study is conducted in response to the high demand for affordable housing units and associated service facilities to meet the needs of disadvantaged groups. The latest publicly accessible Pakistan housing policy which was released in 2001 excluded indicators such as services facilities

associated with the locations of affordable housing projects and residents' preferences. Pakistan is the only country among South Asian countries that faces the highest urbanization, with an annual growth rate of 2.7% in the urban population. Pakistan's population density rose from 48.7 pp/sqkm in 1950 to 286.5 in 2020 (UN, 2019). Even with this fast growth rate, the housing development is around 0.15 million units against 0.35 million demanded housing units in urban areas (Hasan and Arif, 2018). This significant shortage is mainly because of inappropriate housing policies, finances, and planning, resulting in inaccessibility to the urban facilities and giving birth to slums and sprawls.

Additionally, the quality of PT is considered inadequate in RIMA, comprising 95% of paratransit service, i.e., 12-seater pickup wagons and 18-seater Hiace minivans, operating irregularly on limited routes. There is no rail mass transit system in RIMA, but there is a fully functioning single corridor of bus rapid transit (BRT) service launched in 2015 in a dense mixed land, having one end in the Rawalpindi commercial area and the other in Islamabad public offices and Pakistan Secretariat. High low-income levels in RIMA have also caused lack of PT affordability, which is a major problem (Adeel et al., 2016)

The paper examines the degree of residents' location attachment and satisfaction with the built environment around the residence. Statistical models are employed to explore the association of household dynamics with service facilities access satisfaction and the degree of location attachment. It highlights the association of service facilities with residential areas at different geographical locations, focusing on low-income people to determine relative accessibility deprivation. The main findings can expand the literature on accessibility deprivation in urban areas.

The remaining paper is organized as follows: Part 2 reviews the concepts of accessibility, deprivation, and location attachment. Part 3 presents the research area, data collection, and analytical approach. Part 4 provides the detailed findings of the city-wide accessibility score towards service facilities, residents' relative access satisfaction, and overall location attachment. Policy recommendations are given in Part 5, and Part 6 concludes the paper.

2. Accessibility, Deprivation, and Location Attachment

(1) Accessibility

Accessibility or the attempt to define accessibility began several decades ago when different perspectives were established, yet no concrete definition has been put forward. Cowan (2005) stated that accessibility eases neighborhood residents' access to services, goods, places, and other infrastructure in terms of urbanism. The UN Sustainable Development Goals (SDGs) designated "accessibility" to PT as a development indicator and defined it as convenient access to PT for a certain proportion of the population (UN, 2021). Overall, these definitions indicate that accessibility shows the extent to which urbanites in a small city or a large metropolitan area can access services and facilities when made available.

Accessibility to particular urban facilities has become a measuring tool to assess the quality of housing units (Olawuni et al., 2007), residents' livelihood (Apparicio et al., 2008; Ibem, 2012), and service and facilities equitable distribution (Maroko et al., 2009). Knowledge and active research are

increasing into the accessibility to various service facilities for residents of multiple dynamics across the globe. These research activities mainly focus on physical, financial, and economic accessibility. Our study concentrates on physical accessibility which consists of the spatial location of the residents and the distance covered to access various service facilities in an urban area. Apparicio et al. (2008) and Lotfi and Koohsari (2009) also focused on these types of accessibility. Lotfi and Koohsari (2009) argued that it is vital to consider the location of the residential area and the location of service facilities surrounding it to determine the quality of accessibility to service facilities. Physical accessibility explains the association between population distribution and the supply of the services (Islam and Aktar, 2011). Therefore, it is essential to measure the service quality, distance to the services, service location, time taken, and cost when accessing the existing services or facilities to determine the level of physical accessibility.

(2) Deprivation

Researchers have defined “deprivation” as a socioeconomic concept that describes the lack of access to urban facilities amongst disadvantaged groups. Deprivation is measured either for a specific population in an area or a small society. The disadvantaged group is necessarily compared with the relatively well-off group to clearly understand the low-income group's deprivation. Though the measurement method for deprivation has changed over time, current studies focus on measuring the limited access to the various services ranging from food, clothing, transportation to education, housing, and other social services (Maguire et al., 2015; Ouyang et al., 2017; Yuan et al., 2018). The UK's Multiple Deprivation Index (IMD) and the Deprivation Index (NZDep) in New Zealand are popular indices used to measure deprivation.

Inequalities in access capacity to urban facilities affect people's overall living standards and physical and mental health, turning deprivation into multiple deprivations. For example, Maguire et al. (2015) showed that poor access to healthy food leads to over-consumption of less healthy types of food, leading to obesity. Xiang et al. (2018) showed that upward social mobility becomes harder to achieve with poor access to quality education. Therefore, poor access to various facilities impacts not only low-income groups’ quality of life but also the overall development opportunities.

Previous studies have shown that establishing affordable housing at locations with little access to service facilities may result in social issues such as poverty, high crime rate, poor living environment, and low satisfaction level amongst low-income households compared to the financially strong group (Crook et al., 2016; Woo and Kim, 2016; Zeng et al., 2019). Most affordable housing planning and policies focus on providing appropriate housing units for the needy but usually overlook the provision of adequate service facilities for low-income groups (Woo and Kim, 2016). Furthermore, the residents’ satisfaction with the overall built environment and housing location is often ignored. Additionally, studies that attempted to measure the overall accessibility to service facilities lacked development methodologies. Finally, most studies only used statistical analysis and not geographical analysis to determine the accessibility level to service facilities. Since the studies have not focused on geographical analysis, city planners must focus on public opinion when locating public housing units or service facilities.

(3) Location Attachment

This study introduces the term "location attachment," which is the same concept as that of place attachment, space attachment, or community attachment used in previous studies to explain the long-term bond of residents with the location that they are currently living in, as described by Giuliani and Feldman (1993). The term location attachment is part of a project examining the impact of travel behavior in an urban form on location affordability and location attachment. Those who live in a certain neighborhood for a long time tend to develop an attachment to that area and have a sense of belonging (Hay, 1998), making that place part of their self-identity, which shows the importance of the physical environment (Proshansky et al., 1983).

Researchers gave ample attention to identifying the contributing factors that constitute location attachment. Gustafson declared three aspects of place attachment: from one's within, interaction with each other, and interaction with the surroundings (Gustafson, 2001). Overall, the location attachment variables are deeply associated with the psychology and management of the environment since they explain how people react to an environment that they live in for a long time (Patterson and Williams, 2005; Scannell and Gifford, 2010; Trentelman, 2009). Additionally, sociocultural factors can also identify place attachment as they explain the "place identity" and "place dependence" that overall build the dan nature of the sociocultural dimension (Trentelman, 2009). Proshansky et al. (1983) identified a place identity as self-dimensions, meaning the physical arrangement of the combinations of a location. In contrast, Wijaya et al. (2018) referred to place dependence as the utility of a specific location, meaning whether an individual or a group can use the physical arrangement of that location in a way they desire. Nowadays, researchers are developing a model to synergize the interaction of place as a location to perform social activities and nature. Such activities can help one format self-identity (Davenport et al., 2010; Sampson and Goodrich, .2009).

Other than place attachment, previous studies have also examined community attachment, which explains how people connect with the residence location based on the level of socialization that creates an emotional attachment to their homes due to social relationships. The residents' behavior can show this attachment to a particular community within that location (Liu et al., 1998). The residents' behavior and community participation have been declared a benchmark to assess community attachment (Hummon, 1992; Sampson, 1988). Additionally, Gursoy and Denney (2004) suggested that community attachment can also be determined based on how individuals feel about their surroundings and whether they desire to continue living in that community or move somewhere else (Gursoy and Denney, 2004). Overall, studies have shown that one's attachment to a certain place or community and the criteria that provide values to the attachment is very complex and depends on the size, type, and class of the society, social interaction, participation, and residence duration.

Though studies have conceptualized accessibility to service facilities and the level of location attachment to some extent, both elements have been discussed in separate fields with different variables. Further, residents' access capacity to services or facilities, satisfaction level, and attachment to the residence location have not been explored in developing South Asian cities. Therefore, this study aims to integrate these elements by using the case of Rawalpindi-Islamabad, Pakistan, to spatially assess the city-wide accessibility level of service facilities to residence location and statistically examine the access satisfaction and location attachment. The results could also highlight what type of households are deprived of what kind of service facilities. These findings can help develop suitable

planning strategies and housing policies to locate affordable housing units at optimal locations where services, especially PT, provide easy access to low-income groups.

3. Research Area, Data Collection, and Methodology

(1) Research Area: Rawalpindi-Islamabad Metropolitan Area

Figure 1 shows the location of RIMA, the third-largest metropolitan region in Punjab province. The two cities are considered twin cities since they depend on each other economically and socially. Rawalpindi is an unplanned old city comprising scattered settlements, but recently, many urban developers have been attracted to Rawalpindi to develop planned housing communities. On the other hand, Islamabad is a planned city well equipped with a social and economic hub where people from various urban and rural areas migrate to seek employment or higher education. Together, these twin cities contribute 5% to the national GDP.

RIMA has been facing rapid urbanization for the past several years, causing urban sprawl and high vehicle ownership. Sprawl and car dependency help reduce friction in the development of gated communities in the two cities' peripheral regions, resulting in low proximity to PT such as BRT and other informal paratransit services.

Pakistan's national housing policies dictates the development of housing for disadvantaged groups all around the country. However, a housing shortage remains that could facilitate a large volume of low-income groups. Also, housing costs such as monthly rent and housing maintenance are the only parameters mentioned in the national policy to develop affordable housing schemes. At the same time, parameters for transportation costs, land use, and built environment indicators can optimally identify affordable housing locations near service facilities such as education, shopping, clean drinking water, transit, and other infrastructure to establish housing projects.

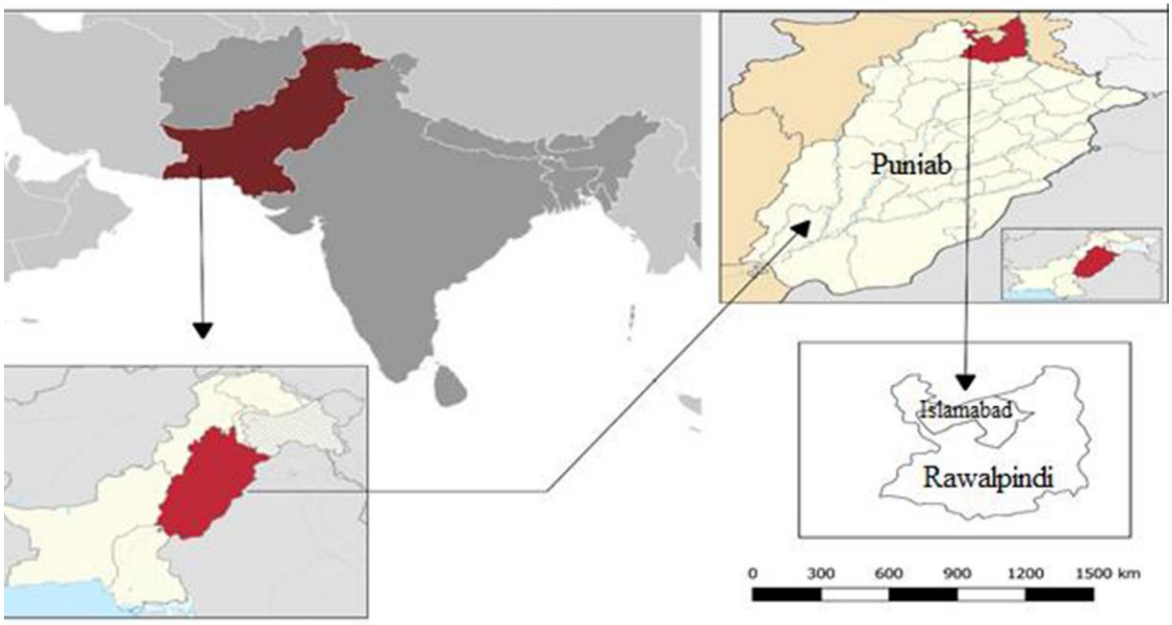

Figure 1 Study area: Rawalpindi-Islamabad Metropolitan Area (RIMA)
Source: Rehman and Jamil (2021)

(2) Data Collection

This study used spatial and statistical analysis to determine access capacity and location attachment among RIMA city core, mid-urban, and suburban households. We incorporated only frequently used service facilities, rather than including every public and private facility in the twin cities usually not regularly visited. Previous studies mainly focused on education, health, shopping, PT, and recreational facilities (Zeng et al., 2019; Lotfi and Koohhsari, 2009); one facility in one case study. This study uses five frequently used service facilities. The names and addresses of these facilities were taken from government and private websites.

Education: All the levels of education facilities are included in this study since a majority of the families have children who go to schools, colleges, and universities. Pakistan does not have an elementary, middle, and high school system. Instead, students receive ten years of school education (equivalent to the first year of elementary until the first year of high school). This is followed by two years in College (equal to second and third year of high school), where students study the introductory syllabus of the fields they wish to choose in university. Therefore, students who graduate school must enroll in college before enrolling in a university; hence, this service is essential for study. From university onwards, the system is the same as everywhere around the globe. The data for education facilities were taken from eduvision.edu.pk., and rcb.gov.pk.

Health: All the levels of health facilities, i.e., hospitals and clinics, across RIMA are included in this study, and they function the same as in any other country. The data for health facilities were acquired from oladoc.com and healthwire.pk.

Shopping: It is challenging to define grocery stores in developing countries like Pakistan. In developed countries like Japan and the US, the low-level stores or the convenience stores are well-established where people shop exactly the way they shop at supermarkets and marts. However, in Pakistan, grocery stores, also known as *Karyana stores* (utility or general stores), are underdeveloped and usually have only one shopkeeper. Customers usually ask the shopkeeper for the items they want to purchase rather than picking the items on their own. The high-level supermarkets and marts function somewhat similarly to those in developed countries. Usually, low-income people visit the grocery stores more often because they cannot afford to shop at supermarkets for expensive monthly groceries. Furthermore, several online phone applications for grocery shopping deliver bought groceries at home. Since the data for the population that uses such applications are unavailable, this medium was excluded. The names and locations were taken from lookup.pk and khappa.pk, where detailed information about grocery stores across Pakistan is available.

BRT: We included only BRT for the analysis because the up-to-date information about the number of buses, station names, route, working hours and fare is readily available on the official Punjab Mass Transit Authority (PMA) website; pma.gov.pk. In contrast, up-to-date information about low-level informal paratransit services could not be obtained; hence, we excluded these services from the analysis. The door-to-door taxi services called using an online application were also excluded since residents do not walk or use any other travel mode to get to taxis.

Drinking water plants (DWPs): To our knowledge, no study has analyzed the access to DWPs before. Since tap water at home is considered highly unreliable for drinking purposes, local authorities have established DWPs across RIMA to allow access to and utilization of clean water free of charge, helping the low-income groups. Though some neighborhoods can easily access this facility, others would either purchase water bottles (around 10 gallons) at the shopping stores or hire companies to drop the bottles at households' doorsteps. We used Google Maps to get the necessary data since no credible website was found for DWPs.

The addresses of all service facilities were then located using Google Maps and then geocoded in ArcGIS for further analysis. We used RIMA's land use map to help to identify the residential parcels in RIMA. Later, Google Earth was employed to extract 1,010 residential parcels because government-made sub-district boundaries of RIMA were not available. These extracted parcels were geocoded in ArcGIS 10.5. When calculating the distances to each service facility, a centroid of each residential parcel was formulated to use them as origins. Since the availability of the national level travel behavior data is an issue in Pakistan, we gathered our primary data by dividing the stratified sampling into two steps. First, we selected nine study sites for door-to-door household surveys based on the distance to the city core, density, and development type. Figure 2 shows the spatial distribution of study sites in RIMA. Second, three sites each were distributed five kilometers, ten kilometers, and fifteen kilometers away from the city core. The white area between the residential parcels and greenery is a mixture of commercial, military, and undeveloped regions.

Table 1 describes the characteristics and sample frequency of each site. The first author noted the household address when distributing the questionnaire survey between February 2020 and April 2020. Out of the total questionnaires of 500 given out, 435 valid responses were collected at a response rate of 87%. The questionnaire survey was divided into three main parts: (1) *household dynamics* such as age, gender, marital status, employment status, income, family size, and frequent travelers, (2) *access satisfaction* with the service facilities in question, and (3) *location attachment* to identify satisfaction with built space of residential location, and desire to live near transit. The first author completed all the surveys by asking questions since many households could not read or complete English questionnaires.

Table 2 summarizes the household dynamics. Out of the total sample, male respondents dominated all three groups, age and marital status were almost equally distributed, low-income and a large number of family members were found to be higher in the city core group, most travelers were within the mid-urban group, and the percentage of working adults was not significantly different.

Table 1 Study sites for surveys based on density, distance to BRT and city core and development type

Study Sites	Site names (sample)	Distance to city center (km)	Description
City core			
1	Asghar Mall Scheme (48)	0 - 5	Highly dense, mixed land, unplanned settlement
2	Naya Mohalla (49)	0 - 5	Highly dense, mixed land, unplanned settlement
3	Askari 10 (50)	0 - 5	Mildly dense, planned, gated housing society
Mid urban			
4	Bahria Town (51)	5-10	Mildly dense, planned, gated housing society
5	Ghauri Town (52)	5-10	Mildly dense, planned, informal housing society
6	PHA Apt. G-11/4 (40)	5-10	Mildly dense, planned, mixed land, public housing society
Suburban			
7	PHA Apt. G-7/1 (60)	10-15	Less dense, planned, mixed land, public housing society
8	PHA Apt. G-7/2 (40)	10-15	Less dense, planned, mixed land, public housing society
9	Sector F-10 (45)	10-15	Less dense, planned, formal housing society

Table 2 Comparison of household attributes across three groups

Housing dynamics	City core	Mid-urban	Suburban	Housing dynamics	City core	Mid-urban	Suburban
Gender				*Family size*			
Male	91.84%	94.41%	82.76%	< 4	18.37%	12.59%	18.62%
Female	8.16%	5.59%	17.24%	4 -7	72.11%	80.42%	80.00%
Age				8 - 11	8.84%	6.99%	1.38%
< 25	1.36%	0.00%	0.69%	12 - 15	0.68%	0.00%	0.00%
25 - 44	39.46%	39.16%	40.00%	*Frequent travelers*			
45 - 64	50.34%	49.65%	48.28%	< 3	32.65%	17.48%	42.07%
65 - 84	4.08%	7.69%	8.28%	3 - 5	66.67%	65.73%	54.48%
> 85	4.76%	3.50%	2.76%	6 - 8	0.68%	16.78%	3.45%
Marital status				*Vehicle ownership*[a]			
Married	90.48%	92.31%	84.14%	Motorbike	71.4%	30.8%	13.1%
Unmarried	9.52%	7.69%	15.86%	Car	51.7%	97.9%	97.9%
Family income				*Occupation*			
0-49,999	66%	1.4%	0.0%	Working adult	76.87%	75.52%	73.79%
50,000-99,999	29.3%	16.1%	13.8%	Unemployed/Student	23.13%	24.48%	26.21%
100,000-149,999	3.4%	30.1%	37.9%				
150,000-199,999	1.4%	19.6%	26.2%				
>200,000	0.0%	32.9%	22.1%				

Note: The family income is in Pakistani Rupees (PKR).
[a], the percentages are the mean values of those who responded "Yes" to motorbike and car ownership.
Source: Authors' analysis from questionnaire survey

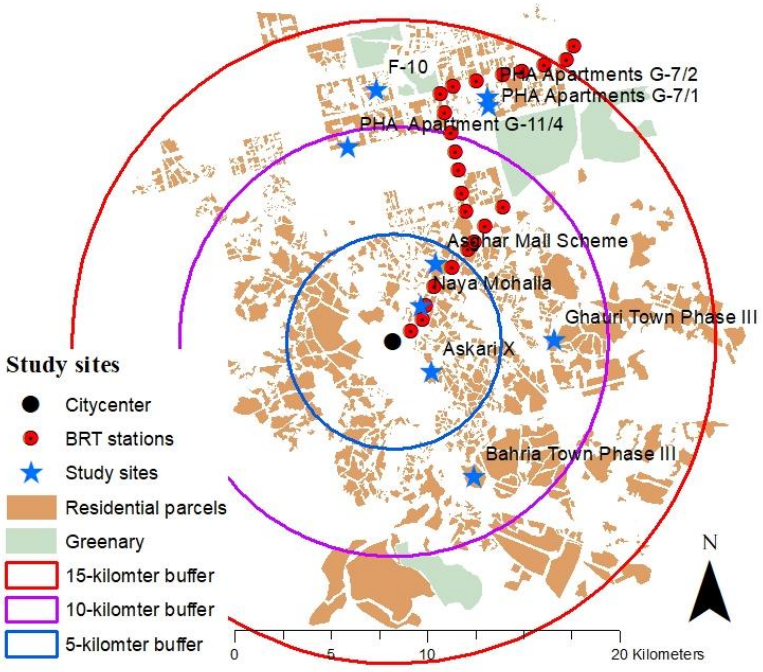

Figure 2 Geographical location of study sites in RIMA

(3) Methodology

First, the city-wide accessibility to five service facilities was examined using spatial analysis. Figure 3 shows the location of each facility in RIMA. Then, the questionnaire survey was employed to examine the households' access satisfaction and attitude towards the built space of the residential location. This integrated method of spatial and statistical analyses is not common in housing and transportation policy studies.

1) Spatial analysis: City-wide accessibility to service facilities

The spatial analysis was conducted to determine the access level to five service facilities in the RIMA context and compare the access satisfaction level of residents living in nine sites. Previous studies have employed various methods to spatially determine the accessibility to service facilities (Lotfi and Koohsari, 2009; Zeng et al., 2019). The "coverage" method can count the number of facilities within a catchment by defining the catchment and determining the accessible locations to households and housing neighborhoods. The "container" method can count the number of facilities within a designated area. The "minimum travel cost" approach requires travel survey data, including travel time, travel mode, and road congestion. The "gravity and two-step floating catchment" methods are the most difficult to employ since they deal with the service or facility level, making it challenging to achieve city-wide. Finally, the "minimum distance" approach measures the distance from one point to the nearest service with a detailed accessibility assessment. It is a widely used method in studies (Su et al., 2017; Zeng et al., 2019). Since residents face difficulty reaching any service facility, we converted the distance, in meters, from residential neighborhoods to service into walking time in minutes. Hence, the distance method was essential for this study. The data for Pakistani district and sub-district boundaries were not available. The boundaries, shown on Google map, ranging from a few hundred square meters to a few kilometers, contain thousands of residents. Therefore, spatial analysis became exceptionally challenging. Thus, taking RIMA's land use map as guidance, residential parcels were extracted using Google Earth and recoded into ArcGIS to be utilized as analytical units to determine accessibility.

Furthermore, the distance from the residential location to any service facility requires an operational measure to show spatial accessibility. The standard distance tool in ArcGIS can measure the shortest path using a road network as a medium. However, in the RIMA context, the updated version of the shapefiles of the road network is not available. Also, it is difficult to determine the path and travel mode that residents usually take to reach the desired facility. Therefore, this study borrows the approach Zeng et al. (2019) adopted when estimating the distance and measuring the accessibility from residential parcels to service facilities. Also, similar to previous studies comparing city-wide accessibility to service facilities with residents' satisfaction, the spatial analysis in this study does not integrate the densities of service facilities and the RIMA population. The residential location choice theory does not dictate that people of certain demography tend to move to a place with no schools, hospitals, public transportation, and clean water. Therefore, regardless of density, we argue that affordable housing should be placed in the area close to the service rather than close to other housing communities.

Similarly, the distance was first converted into walking time since the walk to any service facility from home determines the quality of the built environment (Su et al., 2017). This travel mode is essential because people living in the gated communities away from the city core have less or no access to service facilities within walking distance. Therefore, they are highly dependent on private vehicles

to travel easily. Su et al. (2017) have suggested that residents are reluctant to walk with an increase in the walking time; hence, the residents' tolerance for walking and the walking time fit a decay function. Additionally, an average adult walks at a speed from 55 to 110m/min, and 80m/min is the preferred walking speed (Rose et al., 2005). Therefore, similar to Zeng et al. (2019), this study borrows the same standard. The accessibility levels used by converting the distance and the accessibility scores of each residential parcel are given in Table 3. The evaluated scores for each facility compute the accessibility scores to the facilities for city-wide residential parcels.

The five service facilities were divided into lower-, medium- and high-level dimensions according to their types. Facilities at the lower level are usually located within the neighborhoods that facilitate daily needs (e.g., utility stores, clinics, and schools). Whereas the higher-level facilities traditionally located away from the residential areas provide better and somewhat expensive services (e.g., supermarkets, hospitals, and universities). The service facilities and their divided levels are as follows;

- Education: Higher-level= Universities, Medium-level= Colleges, Lower-level= Schools
- Health: Higher-level= Hospitals, Lower-level= Clinics
- Shopping: Higher-level= Supermarkets, Lower-level= Grocery stores
- Drinking water: Stays as it is
- Bus rapid transit: Stays as it is

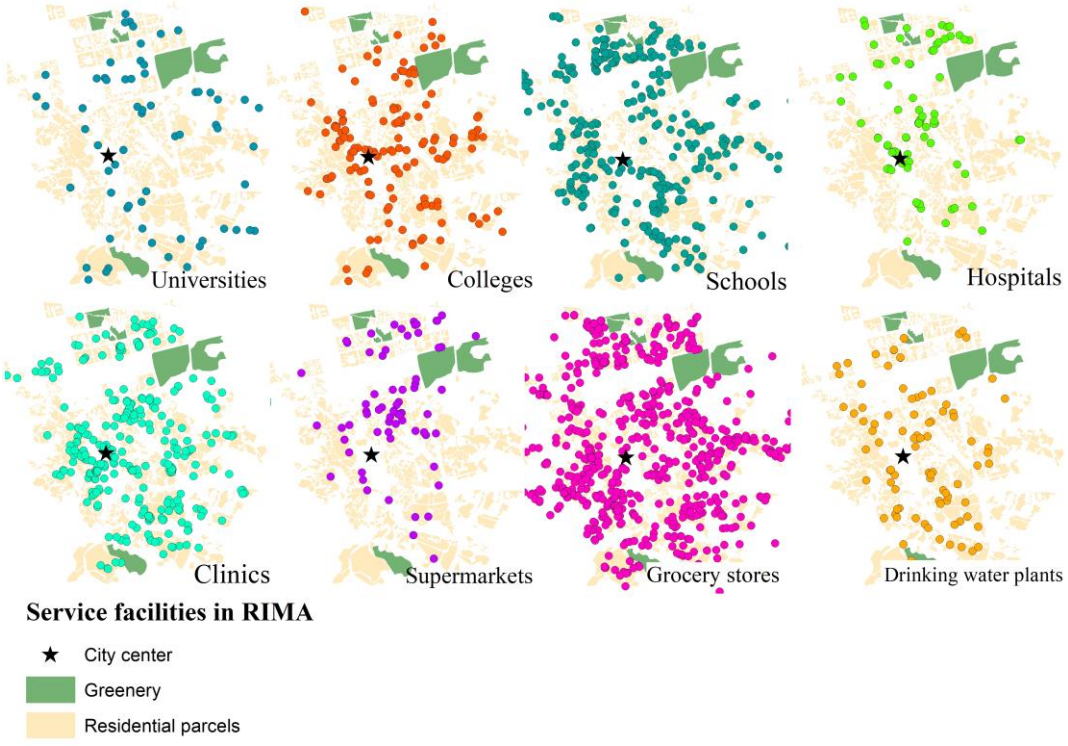

Figure 3 Spatial distribution of service facilities in RIMA

Determining the level of a particular service facility that satisfies the residents' needs depends entirely on their households' dynamics and preferences. For instance, in RIMA, people living near the city core could easily access small-scale shopping stores and preferred to use them rather than traveling a long distance to buy groceries in bulk at the supermarkets. The same is the case with health facilities. On the other hand, suburbanites visit malls, supermarkets, and well-developed hospitals located outside gated communities more often. Though these facilities may be expensive, they provide high-

quality services compared to lower-level facilities. Nevertheless, ultimately people are free to choose their desired level of service facilities. Therefore, city planners in RIMA must consider equal opportunity to access the facilities at all levels regardless of whether residents choose a certain level of service more than others.

Table 3 correspondence between distance range, walking time and accessibility scores

Accessibility measures	Level of accessibility				
	Very Good	Good	Normal	Bad	Very Bad
Euclidean distance to facilities (meters)	≤ 300	300-600	600-1200	1200-1800	> 1800
Walking time (min)	≤ 5	5 to 10	10 to 20	20 to 30	> 30
Accessibility score to each facility	100	80	60	40	20

Source: Zeng et al., 2019

2) Statistical analysis: Household access satisfaction and location attachment

In addition to the spatial analysis, this study employed quantitative statistical analysis to examine household access satisfaction and the attachment to the residence location. This analysis was further divided into two main parts. Firstly, the access satisfaction with drinking water, shopping stores, BRT, education, and health facilities was calculated using a dichotomous category, 0 for "Not satisfied" and 1 for "Satisfied," to examine the extent to which 435 respondents were satisfied when accessing these facilities. Then, the descriptives were calculated for (a) location attachment using a 5-point Likert scale of "1=Much Worse, 2=Worse, 3=Normal, 4=Better, and 5= Much Better," (b) location built-environment satisfaction also using a 5-point Likert scale of "1=Very dissatisfied, 2= Dissatisfied, 3= Do not feel anything, 4= Satisfied, and 5= Very satisfied," and (c) desire to live near BRT using a dichotomous category of 0 for "No" and 1 for "Yes." Table 4 summarizes the descriptives of access satisfaction across the three groups. Table 5 provides the descriptives of the households' location attachment across the three groups.

Secondly, the Anova test was performed for access satisfaction and location attachment variables across the three groups to determine the significant mean difference between the satisfaction level and the extent to which these groups are attached to the location. Levene's test for the equality of variance (Levene, 1960) and Tukey's test of Post Hoc (Allen, 2017) were also performed. The findings are summarized in Table 6.

4. Results

(1) Access Capacity to Services in RIMA

The accessibility scores of service facilities were calculated in RIMA and were divided based on three groups—city core, mid-urban, and suburban. Table 4 shows the descriptive summary of accessibility means scores of service facilities. Except for universities, schools, hospitals, and grocery

stores, all service facilities' access scores and sub-types were higher within the city core region than in other groups. The mean accessibility score of the main types across all the groups ranged from 25.24 (BRT) to 65.31 (shopping) and from 36.98 (universities) to 79.39 (grocery stores) for sub-types. The access scores for universities (41.26) and hospitals (51.37) were highest within suburban areas. The mean scores for schools (69.52) and grocery stores (79.36) were highest among the mid-urban group. BRT service showed the lowest because it is a single corridor line that provides access to only 8% population within ten minutes of walking distance (Adeel et al., 2014). The remaining population who desire to use BRT must take another travel mode to reach the nearest BRT stations. Low access to other facilities indicates accessibility deprivation for such groups.

Furthermore, Figure 4 shows the accessibility score by the residential parcel for all the sub-types, except BRT, since this service is not spread across RIMA. The color-grading from "Red to Dark Blue" indicates "Poor to Very Good," representing accessibility scores. The figure shows that the red color across RIMA indicates less well-equipped services in such areas, meaning low access to such facilities than dark blue areas showing high proximity to several service facilities. Notably, each service facility indicates a unique pattern within RIMA. For example, universities show low access in several parcels of all three groups, hospitals and supermarkets show low access in the southern region of RIMA, and drinking water plants are less in number within the outlying suburban residential parcels. In other words, the straight-line distance of the facilities from the nearest residential parcel is more than 1200 meters, making it difficult for the residents to walk to them. On the contrary, most parcels in all three groups are well equipped with schools, grocery stores, and clinics, indicating that such services are within the range of 600 meters and easy to walk to.

Table 4 Mean accessibility scores of service facilities in RIMA

Service facilities	City Core		Mid-urban		Suburban	
	Mean	St. D.	Mean	St. D.	Mean	St. D.
Education	**56.57**		**54.01**		**50.25**	
Universities	36.98	19.60	38.02	22.00	41.26	22.63
Colleges	68.04	21.04	54.49	22.47	42.61	25.12
Schools	64.69	18.97	69.52	20.22	66.88	22.63
Health	**64.19**		**50.08**		**58.27**	
Hospitals	49.94	22.47	38.82	21.29	51.37	24.29
Clinics	78.44	17.41	61.34	23.83	65.17	23.08
Shopping	**65.31**		**61.44**		**63.75**	
Supermarkets	52.63	25.69	43.53	24.86	49.12	24.94
Grocery stores	77.99	16.02	79.36	17.19	78.38	17.89
Drinking water	**63.13**	18.82	**53.80**	22.92	**41.62**	24.66
BRT	**35.42**	20.53	**25.24**	13.98	**28.90**	17.40

Note:
1. St. D. = Standard deviation.
2. The bold numbers for education, health, and shopping indicate the mean values of the mean accessibility score of sub-types of the respective facility.
Source: Authors' analysis

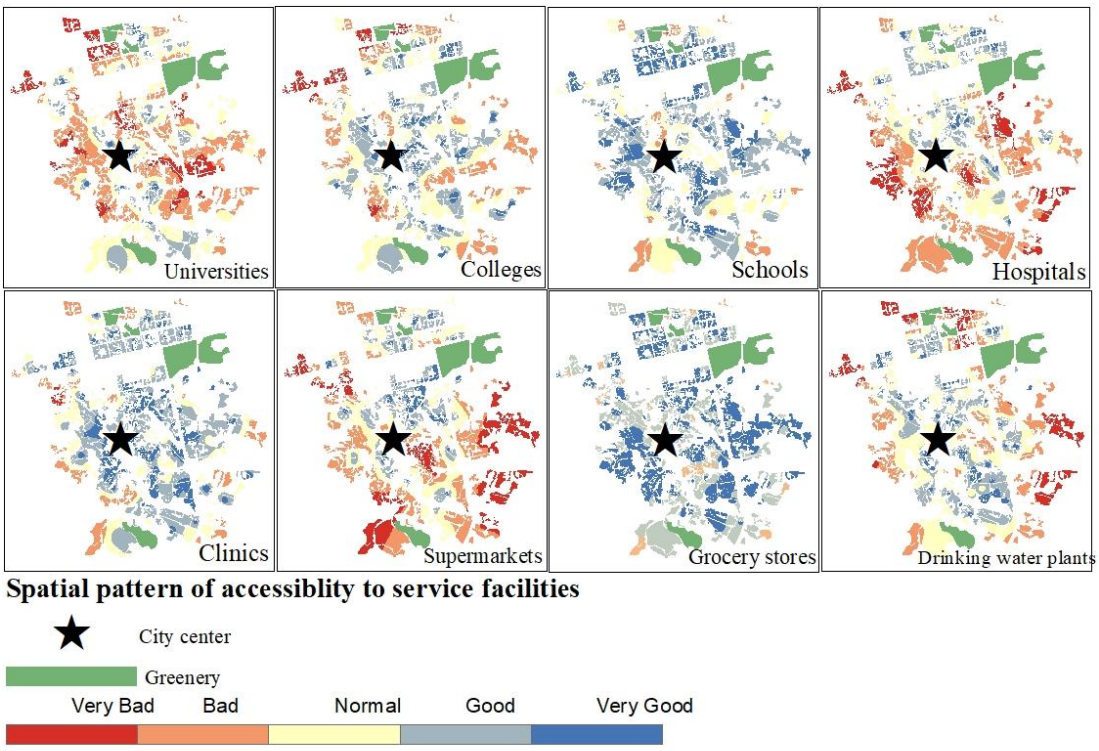

Figure 4 Spatial distribution of accessibility score of service facilities in RIMA
Source: Authors' analysis

(2) Relative Accessibility Deprivation and Location Attachment

Day (2016) and Su et al. (2017) argued that the built environment of the residential area affects the way people feel, behave, and go about their daily lives. The way service facilities are spread in a built environment also impacts the residents' satisfaction level when accessing such facilities. Therefore, this study examined the respondents' access satisfaction with five service facilities as a sub-analysis. The descriptive summary is given in Table 5.

Overall, this cross-analysis indicates disparities in all services across the groups. The city core residents showed the highest satisfaction with health (51.2%) and BRT (59.2%) services compared to other groups, and suburban residents showed the highest satisfaction with education (42.0%), shopping (43.1%), and drinking water plants (45.9%) compared to the city core and mid-urban residents. Notably, residents of all three groups did not show significant satisfaction differences with education, shopping, and health facilities, with low satisfaction with the sample's health facilities. This result could be because small-scale neighborhood clinics might not provide good quality services, even though they are accessible within walking distance, forcing urbanites to visit large-scale hospitals in remote areas. Similarly, city core residents were dissatisfied when accessing education facilities, maybe because they did not prefer such facilities near the neighborhoods due to poor quality and instead commuted to the institutions with higher standards away from the residential area. Surprisingly, the city core residents indicated low satisfaction with shopping compared to other groups. Although spatial analysis showed a "Very Good" accessibility score for grocery stores within the residential areas throughout RIMA, it appears that the local government did not equip neighborhoods with large-scale supermarkets as per residents' demand. Moreover, compared to a low satisfaction level with

drinking water among city core residents and higher among other groups, the spatial accessibility score among city core residents was higher than other groups (63.13 for city core vs. 53.80 for mid-urban and 41.62 for suburban), as seen in Table 4. The reason for low access satisfaction among the city core could be three-fold: (1) the timings of the drinking water availability might be unpredictable, (2) the drinking water plants located within the residential area are always crowded at the time of available water, or (3) the structure of water plants exists but does not provide clean water, forcing residents to visit other facilities away from home. Lastly, mid-urban residents reported the lowest satisfaction with BRT service compared to other services, possibly because of BRT's low coverage area in RIMA.

Table 5 Descriptives of access satisfaction to service facilities

Satisfaction with service facilities	City core		Mid-urban		Suburban		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Education								
Satisfied	40	23.0	61	35.1	73	42.0	174	-
Not satisfied	70	41.4	62	36.7	37	21.9	169	-
Total	110	32.1	123	35.9	110	32.1	343	-
Health								
Satisfied	43	51.2	24	28.6	17	20.2	84	-
Not satisfied	104	29.6	119	33.9	128	36.5	351	-
Total	147	33.8	143	32.9	145	33.3	435	-
Shopping								
Satisfied	75	26.0	89	30.9	124	43.1	288	-
Not satisfied	72	49.0	54	36.7	21	14.3	147	-
Total	147	33.8	143	32.9	145	33.3	435	-
Drinking water								
Satisfied	56	18.9	104	35.1	136	45.9	296	-
Not satisfied	91	65.5	39	28.1	9	6.5	139	-
Total	147	33.8	143	32.9	145	33.3	435	-
BRT								
Satisfied	132	59.2	3	1.3	88	39.5	223	-
Not satisfied	15	15.3	77	78.6	6	6.1	98	-
Total	147	45.8	80	24.9	94	29.3	321	-

Note: The Chi-square tests for all the facilities indicate 99% significant level.
Source: Authors' analysis

The degree of dissatisfaction with access to services significantly influences residents' satisfaction with the location of the residential area where residents are currently living. This satisfaction depends on the degree of location attachment and the built environment of the residential area. It also affects the citizens' desire to live near the BRT service to reach other facilities using BRT. The descriptives of the degree of location attachment and built environment satisfaction and desire to live near BRT are given in Table 6. In contrast, the one-way Anova test of the satisfaction with service facilities and location attachment indicators across the groups are provided in Table 7. Out of the total sample, around 55% of the city core residents felt "Worse" or "Much worse" with attachment to the residential location. Parallel to this feeling, 55% of the city core respondents also felt "Dissatisfied" or "Very dissatisfied" with the built environment of the residential location. However, the majority (87.8%) of such residents desired to live near BRT. This result could be because 71% of the city core respondents owned motorbikes while 51.7% were car owners (Table 2). Mid-urban and suburban groups show almost 100% car ownership. Also, all three groups showed a high percentage of working adults in the households. If working adults in the city core use private vehicles to commute to work, other households would have to depend on other modes to access desired destinations. Hence, they preferred the location that provides better access to BRT.

Moreover, the residents living away from the city core showed a higher degree of location attachment and satisfaction with the built environment; however, they markedly rejected the idea of

relocating to the neighborhoods closer to BRT. The mid-urban residents showed a high degree of attachment to the residential location, i.e., 63.6% of "Better" or "Much better" and the suburban group was 61.3% "Better" or "Much better." Similarly, the percentages of these two groups were almost the same for "Satisfied" or "Very satisfied" with the built environment of the location. Both groups significantly opposed the idea of relocating near BRT. This result is understandable for two primary reasons. First, those living away from the city core report high income, meaning they own private vehicles for mobility (Table 2). Second, households in study sites 7 and 8 could access BRT within five kilometers. In contrast, other sites are not connected with high-quality PT, forcing the residents to travel using private vehicles. Besides, people who are not dependent on PT in RIMA showed high dissatisfaction with the overall PT service quality (Khan, 2021). Table 7 presents the one-way Anova test, which indicates significant differences in service satisfaction, location attachments, built environment, and desire to live near BRT at a 99% confidence level.

Table 6 Descriptive statistics of location attachment and desire to live near BRT

Attributes	City core		Mid-urban		Suburban		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Location attachment								
Much worse	24	16.3	14	9.8	7	4.8	45	10.3
Worse	57	38.8	11	7.7	4	2.8	72	16.6
Normal	44	29.9	27	18.9	45	31.0	116	26.7
Better	22	15.0	87	60.8	83	57.2	192	44.1
Much better			4	2.8	6	4.1	10	2.3
Built environment satisfaction								
Very dissatisfied	24	16.3	14	9.8	6	4.1	44	10.1
Dissatisfied	57	38.8	12	8.4	5	3.4	74	17.0
Do not feel anything	44	29.9	28	19.6	45	31.0	117	26.9
Satisfied	22	15.0	86	60.1	83	57.2	191	43.9
Very satisfied			3	2.1	6	4.1	9	2.1
Desire to live near BRT								
No	18	12.2	129	90.2	136	93.8	283	65.1
Yes	129	87.8	14	9.8	9	6.2	152	34.9

Source: Authors' analysis

Thus, the result of the access capacity to service facilities in RIMA and satisfaction/attitude towards the access to service facilities and the overall residential location can assist the local government when establishing policies to construct low-cost housing for disadvantaged groups. Usually, local governments in many cities develop affordable housing projects near the peripheral regions where accessing health, shopping, recreational, and educational facilities becomes time-consuming and expensive. This low access to services significantly impacts the residents' quality of life. For example, no access to large-scale shopping facilities could prevent residents from obtaining good quality food; no access to health facilities would worsen the health of disadvantaged groups; and no access to high-quality education could jeopardize the children's future, making it difficult to mobilize in the upper social class. However, this study did not directly analyze the correlation between spatial accessibility analysis and health status and children's possible bright future. Additionally, this study did not ask respondents how lack of access to the service facilities in question affects their quality of life.

Table 7 Anova result for service facility satisfaction and location attachment

Service satisfaction and location attachment	Mean square	F	Sig.
Educational unit	2.487	10.472	***
Health unit	1.189	7.856	***
Shopping	4.511	22.070	***
Drinking water	11.556	69.849	***
BRT/public transport	23.054	333.624	***
Attached to community	51.968	59.977	***
Location BE satisfaction	51.327	60.046	***
Live near BRT	31.010	363.376	***

Note: BE = Built environment

*** indicate 99% confidence level.

Source: Authors' analysis

5. Discussion

Many urban planners believe that developing affordable housing can help low-income groups solve their residential problems. Ball (2016) and Varady and Matos (2017) stated that developed cities had neglected to provide Affordable Housing Communities to subsidize households. On the contrary, Woo and Kim (2016) have argued that relocating the residents from centrally located residential areas to newly built affordable housing at urban fringes leads to low proximity to urban facilities. This relocation is a common practice in many developing economies such as Mexico, Brazil, and China that are rapidly urbanizing and causing urban inequalities (Ma et al., 2018; Wei and Chiu, 2018). Even though disadvantaged groups are provided with affordable housing units, their locations are markedly inaccessible. Zeng et al. (2019) have identified that the peripheral location of Affordable Housing Communities causes several social-spatial issues of low or no access to service facilities that in turn causes accessibility deprivation.

This study in RIMA spatially analyzed the accessibility score from residential parcels to service facilities. It concluded that the city core region is relatively well-equipped with various service facilities, providing better access to the mixed-income groups. Low-income households in the city core may feel deprived of opportunities away from the convenient distance because low access to frequently used service facilities impacts poor people more than the well-off group due to a significant increase in transportation costs. Although some service facilities are less in number in one region while in abundance in other areas, well-off residents have relatively better resources to access the desired service than low-income residents, offsetting the influence of low access to quality of life. For instance, the household dynamics in this study's survey showed that a large proportion of respondents in the city core are low-income, with three to five adult travelers in one family. This survey category implies that they are highly dependent on PT such as BRT for their mobility. Since BRT is a single corridor without the integration of the feeder buses, commuters usually take multiple travel modes to access BRT stations (Khan and Shiki, 2018). Subsequently, around 53% of the mid-urban and 48.3% of the suburban group earn more than PKR 150,000, making it affordable to bear the daily transportation expenses. Therefore, service facilities must be located near BRT or neighborhoods of low-income people with no car ownership. After the first phase of BRT in RIMA, the Punjab government has established phase 2 to transport passengers directly to the Islamabad International Airport. The spatial analysis in Figure 4 should dictate new policies for extending the BRT corridor towards suburban study sites, i.e., locations 7 to 9 in Table 1. However, as Haque and Rizwan (2020) have argued, BRT

can facilitate low-income groups and benefit the economy to some extent. Yet, it cannot mitigate traffic congestion, as the primary transportation mode is still private vehicles.

Furthermore, after taking office in 2018, the Government of Pakistan has launched an affordable housing scheme known as the *Naya (New) Pakistan Housing Program* with a vision of providing affordable housing to low-income families across the Punjab province (see https://phata.punjab.gov.pk/). The size of the houses ranges from 817 square feet to 1361 square feet. The official web page indicates that several affordable housing societies provide facilities such as utilities, roads, schools, mosques, commercial areas, fast internet, and other facilities, but they are not located in Islamabad and inner Rawalpindi. Also, no access to BRT or different transportation modes may impact the mobility of low-income groups, leading to accessibility deprivation.

This case study employs spatial accessibility to quantify the access capacity of RIMA residents with five service facilities and a statistical housing survey to examine the accessibility issues of the residents at three geographical locations—city core, mid-urban, and suburban. Though this dual method has been used in a handful of studies (Zeng et al., 2019), it is an effective tool to identify and highlight the socio-spatial difficulties faced by disadvantaged groups. This study's findings helped to understand that residents of all three locations are facing multiple accessibility issues, and the government must focus on these deprivations to establish suitable policies. This mixed-method can be used to deepen the research in the context of accessibility deprivation when aiming to provide affordable housing units in other cities.

The research results have led to three valuable policy recommendations when planning housing or service development projects in the future.

Social and economic opportunities: Public and private developers must not only aim to ensure adequate housing units but also focus on providing social and economic opportunities, such as education, health, PT, clear water, and jobs, to disadvantaged groups. The Rawalpindi and Islamabad development authorities can establish housing units and service facilities simultaneously. This idea applies to all cities and is not limited to developing states; although this type of development plan is not new (Woo and Kim, 2016), it is often ignored (Zeng et al., 2019).

Regular financial aid: The lack of regular funding from the provincial or local governments causes significant challenges to developing and maintaining affordable housing units with better proximity to service facilities (Cai et al., 2017). Wu (2015) argued that local governments acquire substantial fees for land leasing and improved economic activities when dealing with urban redevelopment and gentrification. That is why city officials maintain good locations in a metropolitan area for heavy commercial activities and high-class residential areas, pushing affordable housing and related activities nearer to the city periphery (Fenton et al., 2013). Therefore, diversified financial resources and a partnership with private enterprises can encourage the development of affordable housing and associated services at appropriate locations. Subsequently, local officials must provide attractive incentives to encourage social workers and property developers to establish education, shopping, and health facilities at low and high order for the relocated residents to the newly built affordable residential units.

Consulting residents' opinions: After identifying the residents who want to relocate to affordable housing units, it is essential to understand their views and attitudes. This consultation could help improve the quality of housing units. Organizations such as the Rawalpindi Development Authority and Islamabad Development Authority deal with planning and constructing residential and commercial properties. Ouyang et al. (2017) emphasized that an adequate developing strategy ensures equity when distributing the service facilities around the affordable housing units. Therefore, public opinion is one of the critical elements for future planning processes.

6. Conclusion

This case study of RIMA, Pakistan, attempted to explore the city-wide accessibility of the residents towards several frequently used service facilities based on spatial analysis for distance from residential parcels to service facilities and statistical analysis for household access satisfaction. The findings have revealed that spatial analysis of certain service facilities (Figure 4) differs from what residents feel (Table 5). The survey highlights that residents living in various geographical locations are very dissatisfied with the poor access to essential facilities, affecting their quality of life. This result indicates that residents do not want to use inferior quality services within the neighborhood and instead visit superior quality services in remote areas, especially health and education facilities. Low-income and extremely low-income groups living in the city core feel inconvenienced with the daily, long commuting time to access high-quality education and health services. This feeling furthers their dissatisfaction with their residential location and contributes to failure to form a community attachment. Thus, local government and the associated private partners must consider the location and residents' accessibility when planning to establish service facilities within a community to enhance equity amongst all income groups. Also, paying attention to public opinion and maintaining regard for disadvantaged groups is essential to ensure justice in Pakistani metropolitan cities.

This case study also has some limitations. The authors did not ask the respondents whether they visited the services located closer to a residential area. The urbanites might choose a service facility in a remote area depending on the quality of the service. Therefore, aspiring researchers in this field can focus on household satisfaction with the quality of service facilities that residents from the city core to a suburban region often visit.

This study has concluded that residents in different geographical areas suffer from accessibility deprivation depending on the type of service. However, further case studies should include more service facilities and target the population living in affordable housing units in different Pakistani cities to examine the significant differences and recommend suitable policies.

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