

Analyzing the Impact of Ownership on the Patterns of Use in Residential Rooftops Case Study: New Cairo, Egypt

Mariam Hani Bishai*, Amgad Fahmy

Department of Architectural Engineering and Environmental Design, College of Engineering and Technology, Arab Academy for Science, Technology, and Maritime Transport (AASTMT), Egypt

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Abstract Looking from up-high downwards, the rooftop is the image seen. Rooftops are the upper outdoor cover of any building, where their profiles differ due to some factors, one of which is climate. Cairo, with its hot arid climate, is one of the cities in which most residential buildings are covered with flat rooftops, enabling Cairenes to use and access their roofs. However, what comes first to mind concerning roofs in Cairo are services, including water tanks, satellite dishes, trash, and unused furniture, as well as small rented rooms. Overtime, rooftop uses changed, ending up with having the majority of rooftops perceived as neglected outdoor spaces. Taking roofs as the studied phenomena and the unit of analysis, the author aims to understand the impact of ownership on the patterns of use in residential rooftops. To reach this goal, the author used semi-structured interviews with residents and new development agencies in New Cairo, the chosen case study, as well as personal observation to understand the rooftops' current patterns of use. The results showed that rooftops are in need of more analysis concluding that roofs are used differently according to the roof's ownership (single or multiple), which is affected by the building's ownership and accommodation (apartment, villa, or penthouse), therefore affects the roofs' patterns of use and the resident's roof satisfaction and perception. The conclusion of this research pointed out that there are factors affecting rooftop usage, one of which is ownership as a main, in need for more consideration and reference in design.

Keywords Rooftops, New Cairo, Patterns of Use, Ownership

1. Introduction

The roof is the place where the building directly meets the sky. It is the place where nature is in relation to the building, where sunlight, open view, and fresh air are found. Rooftops, the cover of a building, provide human beings with some of the essential needs for survival, shelter and safety [1]. All buildings, with the variety of typologies seen around, have rooftops. Roof shapes, materials, and uses vary in various aspects: people's needs, building typology, and natural factors. Climate and environmental conditions are some of the most important factors that shape the roof. Countries with bigger roof slopes are those who are likely to have more rainfalls. Flat roofs are mainly found in hot and arid climates, such as that in Cairo, Egypt, which therefore, give more chance for activities to be added and created on the roof.

With the vast increase in population in Egypt, in general, and Cairo, in specific, residential buildings are increasing as seen around. Residential buildings prove to be the land use with the largest coverage in Cairo. Therefore, a large number of flat roofs are left ahead that could be used beneficially and be a valuable property people could use

instead of having most of the roofs unused and full of trash throughout time. Some people consider roofs as the dead upper surfaces of the buildings with the purpose of placing installation pipes, services, etc. [2]. In the “Five Points towards a New Architecture,” Le Corbusier mentioned that almost all modern architecture buildings had flat roofs which resulted in having uninteresting, unresolved, and boring roofscapes. He also states that a roof is not a space to be a leftover and a “full-stop,” however it is a part of the overall building [3]. However, a rooftop is a culture of itself, speaking of what is happening and of the people using or living [2].

Referring back to history, Ancient Egyptians used their residential rooftops in their daily traditional life activities including sleeping, cooking, drying, and preparing food; the roof was perceived as an outdoor space of their residential unit that complements their everyday needs [4]. However, this perception changed and people used rooftops in various ways. At the beginning of this century in Cairo, people used their residential rooftops as a place for maids, drivers, and services (such as laundry or storage rooms) of the “*crème de la crème*”, where each apartment owned a room on the roof. Others used roofs as units rented for people who moved from rural to urban areas and were in need of a small and affordable place for shelter [5]. Recently, with the general idea of reusing rooftops beneficially, a number of research papers, conceptual designs, as well as projects built around, mainly target using rooftops in environmental scopes. Roofs were rented and invested in solutions mainly restricted towards adding photovoltaic cells, renewing energy, and planting roofs, creating agricultural rooftops [6]. However, during Covid-19 pandemic, Cairenes started using rooftops as a shared outdoor gathering area, when public areas were closed and people were not able to meet or gather. From this perspective, with the inconsistent use of rooftops, the researcher finds a research gap and interest bringing out these questions:

1. In residential buildings, with the various types of accommodation, who owns and has full control over the roof?
2. How does roof ownership affect the way people use and perceive rooftops?
3. What are the different patterns of use created on residential rooftops?

This research aims to study and analyze the effect of ownership in shaping the rooftops' patterns of use and highlight the privilege of using and considering flat roofs in design. To reach these goals, the research is divided into three parts, as illustrated in figure 1. Part one mainly focuses on highlighting relevant literature review, creating a theoretical framework. The researcher begins by referring to literature to understand the way Ancient Egyptians used their residential rooftops, how Cairenes perceive and use their residential rooftops especially during the early 50s, and point out the turnover that

happened during the pandemic and how Cairenes used their rooftops. This helps create an overview of different patterns of use that will be then tested and analyzed in order to find out how the difference in rooftop ownership affects and leads to the current rooftop uses. To narrow down, the researcher understands the Egyptian roof building regulations and limitations of residential buildings in order to take any restriction into consideration while testing. Part two is mainly concerned with the method, tests, and results reached. As a means of understanding rooftops, New Cairo is the chosen case study for this research. New Cairo includes various types of residential buildings, ranging from apartments, penthouses, to villas. This variety of accommodations varies in both building and roof ownership which will help in framing the impact of ownership on the patterns of use created on residential rooftops. Each type will be studied and analyzed, through conducting semi-structured interviews with residents (a total of 134 residents) and discussions with new developers in New Cairo (a total of 3 developers) in order to find out how ownership affects the current patterns of use in the variety of residential units. Finally, part three concludes and discusses all relations tested, referring back to the literature review.

2. Literature Review

2.1. General Rooftop Usage in Cairo

Looking back to the Ancient Egyptians, residential rooftops were of great use. Almost most of their houses had flat roofs. The roof was owned by one family owning the house, which enabled them to have full control over the rooftop and use it regularly. Uses varied, however, were shared in complementing their traditional everyday life needs, as shown in figure 2. Ancient Egyptians, in their traditional life and culture, preferred spending time mainly on top, on their residential rooftops. They used their roof as a secondary living area, a primary sleeping area and relaxing, and a recreational space where there is a cool breeze, especially at night [7]. Not only for relaxation, rooftops were also used to prepare food. They used to dry and make salted meat and fish as well as cooking [4]. All these potential uses are due to the climate's privilege that shaped the rooftops as flat. Roofs were reached through the main staircase of the house, which enabled all residents to access the rooftop, as shown in figure 3. It is said that the cooking space, the kitchen, is reachable from the house's roof where Ancient Egyptians used to gather for eating, resting, talking, and creating family relations and discussion. Besides the previous uses, Ancient Egyptians had a specified space for storage in their residential. This space was mainly used to collect trash, store their baking and cooking tools, place their kneading, collect water jars, as well as store their oven tools.

Ancient Egyptians beneficially used their residential rooftops, perceiving the roof as a part of their house not a leftover, which is seen in the way they used their rooftops (ranging from using their roofs in their everyday life to personally using the roofs for relaxation and recreational activities [8].

After the era of Khedivial Cairo, around the early 50s, Cairo had a vast and dramatic change in the urban and architectural patterns. Many heritage and historical buildings, that were of unique style and defined use, turned into an ugly and distorted buildings; façade treatments changed, balconies were closed, AC compressors were added on the façade, as well as rooftops were homed by working people who took control over a number of

rooftops. These people were said to pay no rents or taxes as they were considered from the informal economic sector of Cairo. Roofs were then used in a way to complement their daily life with the impact of their cultural background. This led to the general image and perception found in the minds of all Cairenes. Yacoubian building, Downtown Cairo, could set as a perfect example to show the dramatic change of rooftop uses during this period. The Yacoubian building was built around 1934 by an Italian architect who was trying to construct buildings in Cairo using his Western style inspiration. He decided that all residents should be from the elites of the society, ministers, foreign businessmen, and millionaires [5].

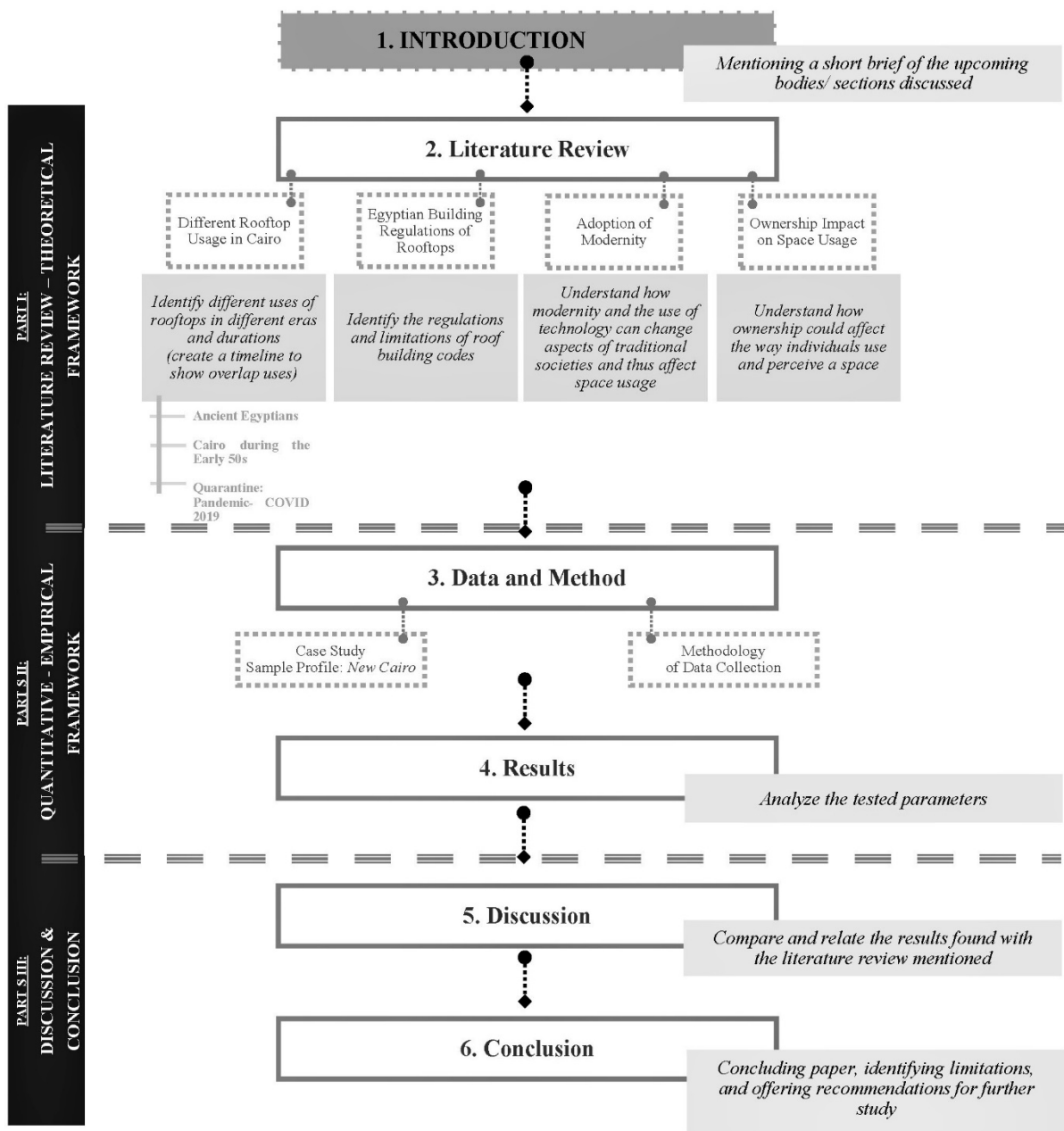


Figure 1. Research Structure

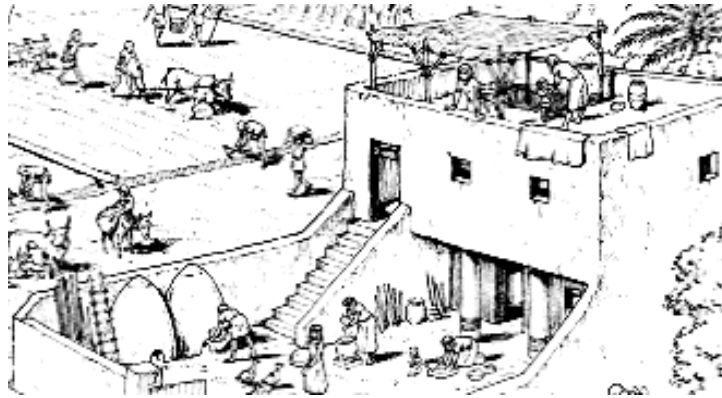
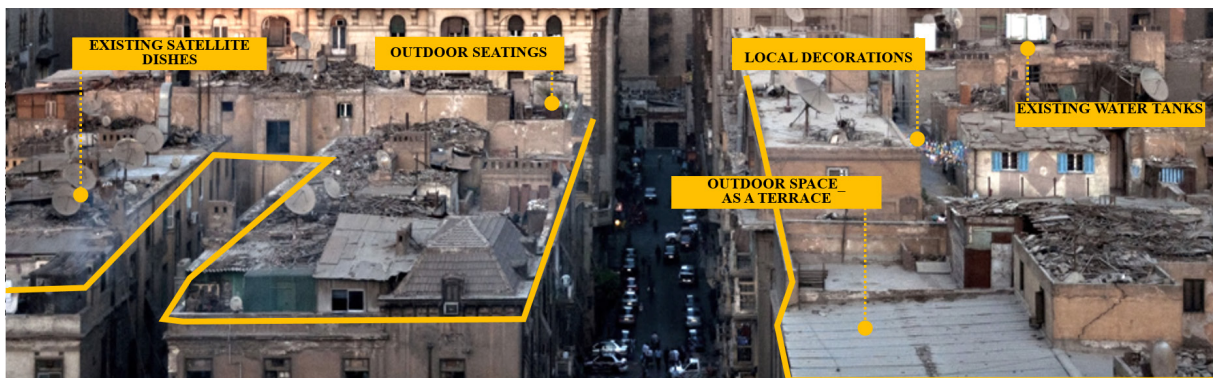


Figure 2. Ancient Egyptian Residential Rooftop Uses [17]



Figure 3. Ancient Egyptian Residential Rooftop Uses [18]



Figures 4. People of the Roofs (HOME), Downtown Cairo [19]

Pointing out on rooftops, the main scope of this research, the roof of Yacoubian's building had two rooms specified for the doorman and his family and the rest of the roof had around fifty-metal structured rooms, each measuring not more than two square meters, where each apartment owned and had full control over one small room. These rooms were used for food storage, dog hosting, as well as for laundry uses, and were never used as rooms for servants. After the Egyptian Revolution in 1952, when people started moving from rural to urban areas, Cairenes' way of life changed and this was clearly reflected in the way they used to use their residential rooftops. Apartments of Yacoubian's building, as the focused example, became owned by Egyptian police and military officers. The roof changed and became used as a space for servants, drivers, and chefs. Urbanization had a cultural impact on rooftop patterns of use; residents used the roof as a space for poultry, pigeons, and rabbits' husbandry. As time passed, people started selling the rooms on the roof to people who were in need of a small space for shelter and living. Since then, the roof became a separate independent space creating its own way of living; "people living on top." Around the late 70s, roofs were a home for the working class and for unaffordable people, where they occupied all their daily needs, but with their own way of use, as analyzed in figure 4. The roof became a place with a separate life away from street life. This use and perception took over most rooftops in Cairo, specifically, leaving a memory of rooftops to be leftover, dead, or unorganized spaces [5].

During the COVID-19 pandemic, people were all enclosed in their personal space. They could only gather at

home when all the public spaces were closed. However, the nature of human beings is always in need of sun and fresh air exposure. Almost all families figured out the importance of having and using an outdoor private space in their residential unit, such as balconies, roofs, and gardens, for their mental and physical health, especially for kids and old people [9]. People, who live in villas or ground floor apartments with access to gardens, used them as their breathable private space. Others, especially those who live in apartments mainly on typical floors, used their balconies instead. Unfortunately, the majority didn't have the luxury of having other spaces to get outside their private residential spaces. However, during the quarantine, there was an urban evolution and transformation, a turn-over, which is the use of rooftops, especially those of the residential buildings. The lockdown made some people focus more on using every space in their residential property, one of which is the rooftops, the breathable outdoor space. People changed their everyday life habits to cope with the sudden outbreak of the pandemic. Everything was done at home [2]. Cairenes used their residential rooftops for different activities such as social gatherings, praying when mosques and churches were closed, playing sports and music, and organizing birthdays, engagement parties and weddings, as shown in figure 5. Roofs were reshaped and reused to accommodate daily life activities and substituted the outdoor public spaces. This enhanced the awareness of a few people to use their rooftops, changing the general perception of a dead and leftover space into a livable place. Figure 6 summarizes the general rooftop uses in Cairo as discussed above.

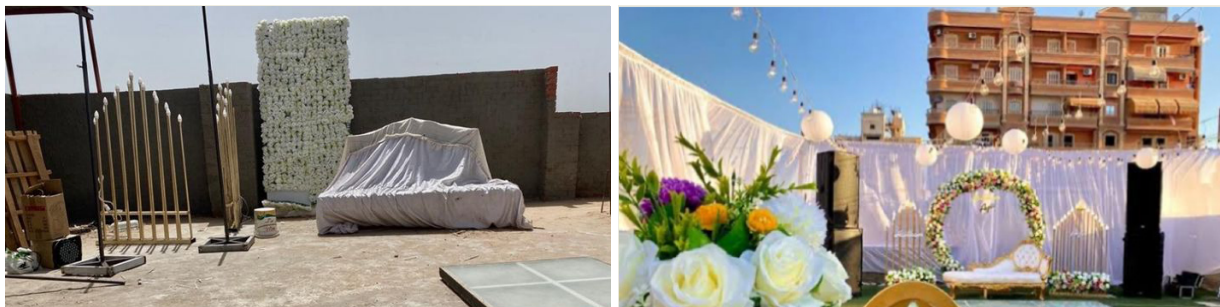


Figure 5. Roof Events during Pandemic_ Before and After [20]

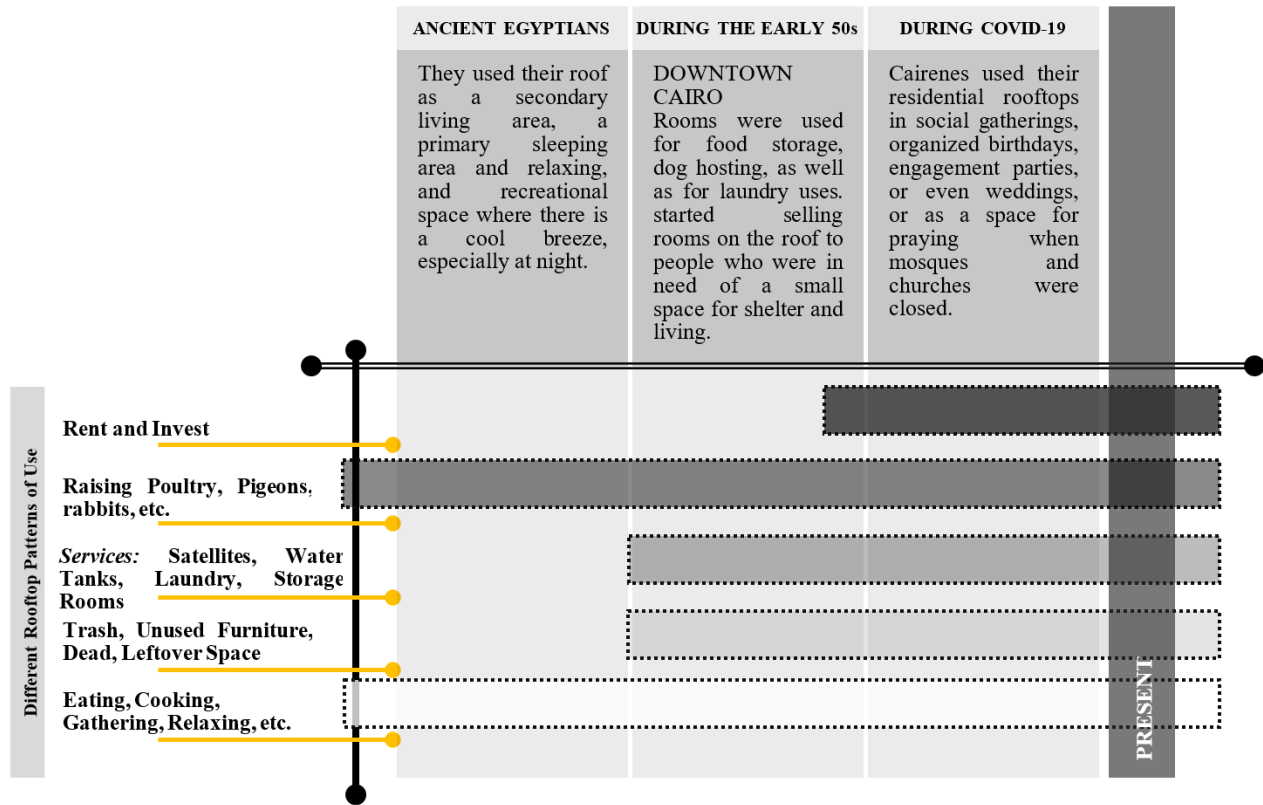


Figure 6. Timeline of the General Rooftop Usage in Cairo

2.2. Egyptian Building Regulations of Rooftops

Rooftops represent a high percentage of the total area which covers any city. The more buildings, the more the roofs. Looking at the rooftop as a gap that needs concentration, reusing rooftops, specifically flat roofs, is a privilege that could enhance and utilize urban lands. In Egypt, most of the rooftops have no common or defined use, creating a problem in classifying a certain typology for rooftops. This issue creates an undefined perception towards using the rooftops leading to having most of the rooftops seen as unresolved, ignorant, unused, and a leftover space [6]. There could be a variety of patterns of use in the same district, which ensures the inconsistency of using the rooftops; scaling from totally ignoring the roof up-till efficiently using the roof.

As all buildings should be built upon the regulations of the country, referring to the Egyptian general regulations updated on July 7th, 2022, rooftops of any residential buildings should include a constructed mass that doesn't exceed 25% of the total area of the roof, supporting what is mentioned in article 104 of the Egyptian building executive regulations law no. 119 for 2008. This percentage includes staircase and elevator rooms, storage spaces, or any other brick-work enclosed space. However, lightweight structures, such as wood or steel, could be used for more enclosure of spaces on the roof [10]. According to Egyptian law no. 131 of 1948 issued by the civil code article no. 856, if a property is multi-story, owners are

considered equal in sharing common facilities and spaces in the building (entrances, corridors, staircases, rooftops, etc.). These spaces could not be divided among residents. It is shared among all property residents, unless it is clearly stated in the contract of the residential unit that any of these spaces, the rooftop for instance, is owned by a defined resident [11]. Therefore, ownership could be tested as a factor in order to understand whether it has a direct impact on the patterns of use found on rooftops.

2.3. Adoption of Modernity

From the Ancient Egyptians till present, as discussed above, it is clear that the difference of uses in architectural spaces, rooftops in specific, changed. Adoption of modernity is an important factor. During the traditional Egyptian societies, rooftop uses were very simple and targeted main to complement the everyday life needs of residents.

Throughout time, technology emerged and ideas changed. People started integrating technology into these everyday life needs; satellite dishes were added on the roof to offer channels to be watched and water tanks as well to provide residents with water. Technology did not stop there; later on, PV cells and solar panels and green roofing were introduced and generally roofs, the empty and neglected space, were seen as the most suitable place to add them. Hence, it can be clearly mentioned that with all the political and economic changes and the emergence and spread of the

ideas of modernity in Egypt and all over the world, dramatic changes shaped not only the themes of interior design and furniture, but also the buildings inside and outside (especially residential typologies) and the way people perceive and use the spaces [12].

This dramatic change with and adoption of modernity changed the taste of the traditional societies. Traditionally, houses were mainly low-rise buildings, where a single family lived all together and beneficially used every single space of the house from the basement (if found) to the roof, as seen in the houses of the Ancient Egyptians. However, with the use of technology, the overcrowding of the city, population, and the high land value, high-rise buildings were built to accommodate the large number of people. The idea of building mass production for accommodating large number of tenants decreased the individual's level of ownership and sense of belonging to the space. Building using new technologies was mainly for providing solutions and solving problems while negating the traditional ideologies of the city and its people [13].

One of the famous modern architecture housing examples that was demolished, figures 7 and 8, due to the high crime rates and vandalism behavior from the residents is Pruitt-Igoe, north side of St. Louis, Missouri. Clearly, there were a number of economic and social factors that played the role in the failure of Pruitt-Igoe. The brief description most architects mentioned for the reason behind this fall is "the design to blame." Referring back to the principles of Oscar Newman, crime and vandalism behavior from tenants resulted from the lack of the sense of belonging and the indefensible sense towards the used communal spaces. Corridors were relatively very long. Residents had no control, sense of belonging towards shared spaces, such as Entrances, staircases, corridors, and

all shared spaces. This is due to the large number of people sharing the use of spaces, which affects the percentage of the individuals' control and ownership towards a territory or a space. Thus, residents were filled with undesired behavior including violence, vandalism, and crimes, towards these spaces, as seen in figure 9. Therefore, demolishing this project was the best solution to this project [14].



Figure 7. Pruitt-Igoe Housing Project [21]



Figure 8. Failure Pruitt-Igoe Housing Project [22]

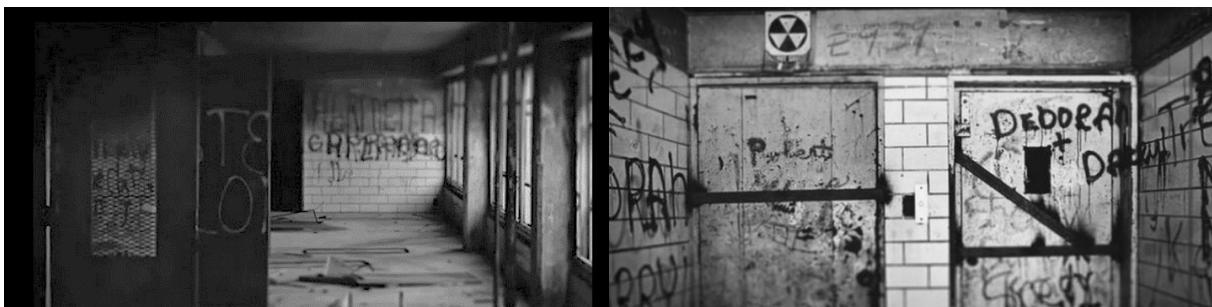


Figure 9. Crimes and Vandalism in Pruitt-Igoe Housing Project [23]

From this perspective, it can be seen that with the adoption of modernity and the idea of mass production and the typical residential building designs, an individual can lose the sense of fully controlling a space; ownership. With a lower degree of ownership, the sense of belonging to the space and the distinctive identity to the space decreases.

2.4. Ownership Impact on Space Usage

Focusing on residential buildings in studying the rooftops, ownership is a key factor; who owns and thus, who has the right to control. The owner has the full right towards the property s/he owns. The grade of control decreases as the area or space is more towards being public. Spaces could be either private, semi-private, semi-public, or public. As the space gets accessible to everybody and has no defined or definite owner, it is categorized as a public space. However, when the space is not accessible to everyone and has a definite owner, it is categorized as private, creating a clear defensible space, referring to Newman's theory. This makes a different sense of ownership, territoriality, and defense towards space. The larger number of people sharing a territory, the less an individual feels control and right towards this territory. When there is a large number of people owning or sharing a space, the individual's percentage in the space decreases. This could result in people having difficulty identifying the space, taking full control over it, and thus having a problem in using, determining, and adding activities to this space. In a residential unit, the number of floors, number of dwelling units, and number of tenants affects the number of people using the property, hence, affecting the way people control and use the space [15].

From this point, the researcher is interested in analyzing the way ownership affects the patterns of use in residential rooftops on various scales; roofs owned by a single family or by multiple families. In the scale of a villa, for instance, the building property is owned by a single family, where every space is shared among all family residents from the garden to the roof. However, in a multistorey apartment building, control over spaces totally differs. Here there are multiple families sharing spaces, such as corridors, entrances, staircases, etc. Yet, penthouses are residential units in a multistorey building, however, roofs are owned by a single family, where the roof is a part of the penthouse unit. This variation of ownership differently shapes and affects rooftop usage. Focusing on rooftops, the unit of analysis of this paper, do residents misuse or even neglect using their residential rooftops due to the large number of people sharing the same space, thus individuals don't have full control and freedom of choice towards this space? This research tests whether ownership could clearly affect the way people, of different property types, use their rooftops and the patterns they create. The following section will

explicitly explain the data and method used for testing.

3. Data and Method

In order to reach the goals and find answers to all the proposed questions, this research uses double layers for concluding an analysis and finding out results. The first step is describing the area of the chosen case study and justifying the reason behind choosing it in particular. The second step is stating the data collecting tools used as well as describing the collected quantitative data from interviews, personal observations, and questionnaires and defining the aims behind the chosen and targeted questions.

3.1. Case Study: New Cairo, Egypt

New developments are the main current stream of the urban enlargements, focus, and interest of governmental approaches for urban developments. Choosing New Cairo, in specific, is mainly for opening the gate of awareness towards rooftop usage and understanding and investigating whether developments value rooftops or are still neglecting and misusing roofs. New Cairo is one of the new Egyptian urban enlargement cities which includes a variety of types and standards of living communities; low, middle, and high-income communities, as shown in figure 10. Selecting New Cairo, as the case study of this research paper, helps the researcher perceive and understand a variety of rooftop patterns of use in different residential units: apartments, penthouses, and villas, where the level of ownership differs. With this variety of accommodation types, building ownership is seen to directly affect the rooftops' ownership and territoriality, hence affecting the type of use added to the roof. With the variety of developers found in New Cairo, the researcher could also understand the different perceptions of roofs and consideration in design; how governmental and private developers consider the use of rooftops. Same district, with different users (different owners), could result in different patterns of use, therefore different perceptions.

Recently, referring back to the idea of renting small rooms on residential rooftops, new developers started thinking of investing in roof properties as dwellings or penthouses. This helped in reshaping the roof and changed it from a leftover and dead space to a valuable space that is part of the house. An owner of a penthouse is a defined user who has full control over a selected part of the roof. This could relate and ensure that the scales of ownership could affect the way people deal with spaces, which will be discussed in a later section.

Figure 10. New Cairo Map (Author, 2021)

3.2. Data Collection

In order to understand and investigate the different patterns of use and test the impact of ownership, as a main factor and how it could affect the roof usage, the researcher, at first, had a general personal observation (on roofs of apartments, villas, and penthouses) and discussions with new development agencies in New Cairo. This step created a preliminary overview that helped in constructing the questions that will be used later in the semi-structured interviews with residents. Each question was asked in order to point out and collect a general overview of rooftops and specifically to help in reaching the research goal upon studying the impact of ownership on rooftop usage. Questions were mainly targeting the three scopes. First, understanding the residential property; mainly asking about the district, enclosure, type of accommodation, ownership of the building, year of construction, and number of floors and units per floor, as follows:

● **Q1: Gender.....**

- Female
- Male

(Aim__ a basic data question for collecting different perceptions)

● **Q2: District: Where do you live in New Cairo (e.g. First Settlement, Banfseg, etc.)?**

(Aim__ define and split developments and define the variety of income levels)

● **Q3: Enclosure: Do you live in?**

- a stand-alone property
- a compound/ gated community

(Aim__ define property enclosure)

● **Q4: Accommodation...**

- Apartment
- Villa
- Studio

*(Aim__ state the type of accommodation; reflect the impact of **ownership** on rooftop usage, activities, access, and accessibility)*

● **Q5: Building Ownership: Is the building, you are living in, owned by a single or multiple family?**

- Single family
- Multiple families

(Aim__ understand the ownership status of the property, therefore affecting roof accessibility and usage)

- **Q6: Year of construction (could be a range: e.g. between 2001-2002)...**

(Aim__ map changes in rooftop uses and understand the different perceptions towards rooftops)

- **Q7: No. of Floors: How many floors is the property (e.g. Ground + 2)?**

(Aim__ roughly totalize the number of residents of the building, which therefore could affect the residents' territoriality of the building's rooftop (affecting the percentage of roof ownership for each unit)

- **Q8: Flats/Floor: If living in an apartment or a studio, how many flats per floor is the property?**

(Aim__ add another layer of calculating the total number of residents; relatively create a vision on the average area of the roof)

Second, investigating the building's rooftop and the resident's relation to the roof; asking about the roof's shape, access, accessibility, ownership, resident's satisfaction, as well as the current activities occupying the rooftop, as follows:

- **Q9: Shape: Is the rooftop of your property FLAT?**
 - Yes
 - No

(Aim__ understand whether the roof is capable of being used or has no room for any activity to be added due to its shape (being pitched or gabled, for instance, doesn't allow the room to accommodate any activity unlike flat roofs))

- **Q10: Is the rooftop accessible?**
 - Yes
 - No

(Aim__ understand whether users have access to the roof, hence, allowing residents to use the roof)

- **Q11: Accessibility: If yes, how is the rooftop accessed?**
 - By the main building's staircase
 - An outer staircase

(Aim__ understand whether the roof is accessed from inside the building where it is easy for all users to access the roof)

- **Q12: Roof Ownership: Current ownership condition of the rooftop...**
 - Owned by a single family
 - Owned by multiple families
 - Rented
 - Other (no defined owner)

(Aim__ define the ownership and territoriality of the property's roof, which will then reflect on the activities occupying the roof as well as the individual's satisfaction towards the rooftop; understand who has full control and defense over the roof)

- **Q13: Satisfaction: To what extent are you satisfied with the current rooftop design of your building?**

- Very Unsatisfied
- Unsatisfied
- Neutral
- Satisfied
- Very Satisfied

(Aim__ understand the residents' satisfaction towards the activities occupying the rooftop; conclude the residents' perception towards using the rooftop)

- **Q14: Usage Occupation: Rank from the following the usage/components that largely occupies the rooftop? (where 1 is the least occupied and 5 is the most occupied).**

- Services (satellites, water tanks, etc.)
- Unused Furniture
- Storage Spaces (enclosed area)
- Zoned Activities (enclosed Living area, social gatherings, dining, animals/birds' husbandry, etc.)
- Empty Unused Space

(Aim__ understand and determine the level of the residents' awareness towards the idea of using the roof; understand the percentage of occupation and to what extent do residents use the roof beneficially)

Last, an additional question for discussion was asked targeting knowing the residents' general perception towards a rooftop, as follows:

- **Q15: Background: Generally, What comes to mind when you hear the word "rooftops"?**

(Aim__ understand the general perception of the resident towards the roof that could be impacted from a personal memory or cultural background)

After constructing the questions, a pilot study was conducted on around 9 participants (three residents from each accommodation) in order to test the structure of questions and spot any chance of misunderstanding, uncertainties, or confusion before starting the main sampling of this research. The pilot study created some minor and proper adjustments in some questions, as follows:

- **Q4: Accommodation...**
 - Studio → PENTHOUSE
 - Apartment
 - Villa

- **Q12: Current ownership condition of the rooftop...**
- Owned by a single family
- Owned by multiple families
- ~~Rented~~ → responses were added to “Owned by a single family”
- ~~Other (no defined owner)~~ → responses were added to “Owned by a single family”

Then, the researcher was ready to start conducting the interviews with New Cairo residents. The sampling of this research was a stratified random sample of residents living in different types of accommodations (apartments, villas, and penthouses). Participants were randomly chosen; mainly ensuring that they are New Cairo residents from the question added, question 2, in the structured

interview and the online questionnaire asking about the district they are living in, which was not an optional question not to be answered.

Data saturation was reached after conducting around 30 apartment residents, 15 villa residents, and 15 penthouse residents. In order to have a reasonable amount of data for analysis, the researcher created a shared online questionnaire with New Cairo residents, using the same questions constructed. Around a total of 134 New Cairo residents participated in the semi-structured interviews and answered the shared online questionnaire. Responses, collected from the semi-structured interviews and those gathered automatically on Google Sheets from the online questionnaire created on Google Forms and shared, were all sorted and tabulated on Microsoft Excel. Figure 11 summarizes the data collection process.

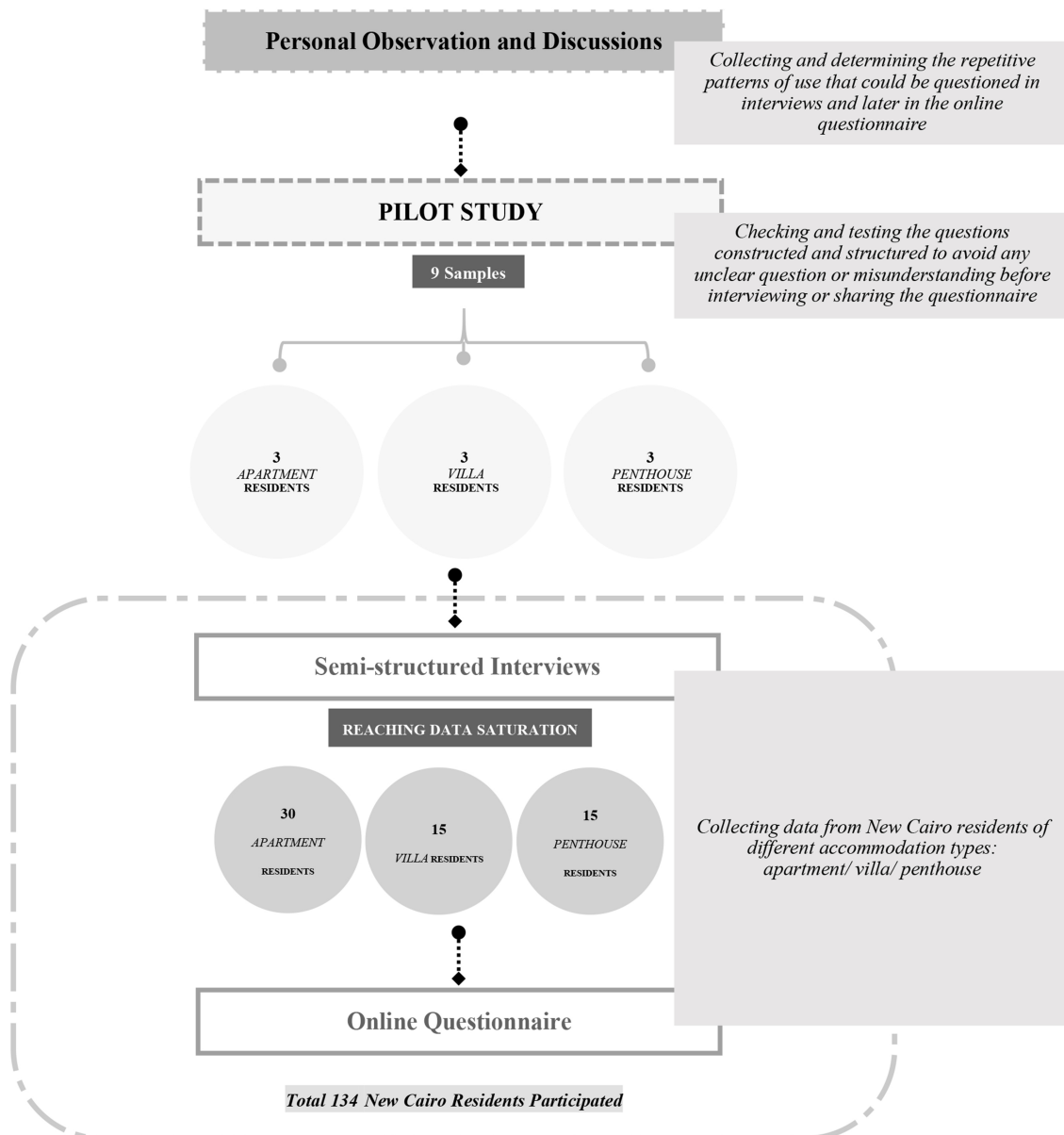


Figure 11. Data Collection Process

4. Results

After settling all responses collected from interviews and questionnaires, the researcher coded the collected outcomes, tested samples, and created relations through the use of IBM SPSS Statistics Version 25. Questions and responses were added and coded as variables, then an overall descriptive frequency calculation was made on all responses in order to find out a preliminary relation between the different parameters. Table 1 summarizes the first layer of identifying frequencies, percentages, and means of all conducted questions. With a quick view of the frequencies and means calculated, the researcher created

main relations between variables, taking into consideration ownership as the main factor in focus. This relationship, shown in figure 12, helped in finding out the main elements that are in need of correlations and further sampling tests. The relation enhances the impact of the type of accommodation (apartment/villa/penthouse) on rooftop usage. Different accommodations create different scales and degrees of building ownership as well as rooftop ownership; considering roof shape, accessibility, and access. Consequently, ownership could affect the residents' satisfaction towards roof design and the patterns of use created on rooftops.

Table 1. Responses of Participants_ Frequencies and Means

	Question	Code	Frequency (N)	Percent (%)	Mean	
1	Gender	• Female	1	72	53.7	1.45
		• Male	2	62	46.3	
2	District	• Low-income communities	1	31	23.1	2.12
		• Middle-income communities	2	56	41.8	
		• High-income communities	3	47	35.1	
3	Enclosure	• a stand-alone property	1	75	56	1.44
		• a compound/ gated community	2	59	44	
4	Accommodation	• Apartment	1	69	51.5	1.74
		• Villa	2	31	23.1	
		• Penthouse	3	34	25.4	
5	Building Ownership	• Single family	1	31	23.1	1.77
		• Multiple families	2	103	76.9	
6	Year	• Not mentioned	0	21	15.7	1.97
		• 2000-2005	1	34	25.4	
		• 2006-2011	2	30	22.4	
		• 2012-2017	3	26	19.4	
		• 2018-2022	4	23	17.2	
7	No. of Floors		vary	vary	vary	4.29 ≈ 4
8	Flats/Floor		vary	vary	vary	2.76 ≈ 3
9	Shape (Flat)	• Yes	1	117	87.3	1.13
		• No	2	7	12.7	
10	Accessible	• Yes	1	130	97	1.03
		• No	2	4	3	
11	Accessibility	• Not accessible	0	4	3	0.97
		• By the main building's staircase	1	130	97	
		• An outer staircase	2	0	0	
12	Roof Ownership	• Owned by a single family	1	65	48.5	1.51
		• Owned by multiple families	2	69	51.5	
13	Satisfaction	• Very Unsatisfied	1	25	18.7	3.06
		• Unsatisfied	2	22	16.4	
		• Neutral	3	29	21.6	
		• Satisfied	4	35	26.1	
		• Very Satisfied	5	23	17.2	
14	Usage Occupation	• is the most occupied and (5) is the least occupied				3.28
		• Services (satellites, water tanks, etc.)				1.60
		• Unused Furniture				3.33
		• Storage Spaces (enclosed area)				3.21
		• Zoned Activities (enclosed Living area, social gatherings, dining, animals/birds' husbandry, etc.)				3.55
	• Empty Unused Space					

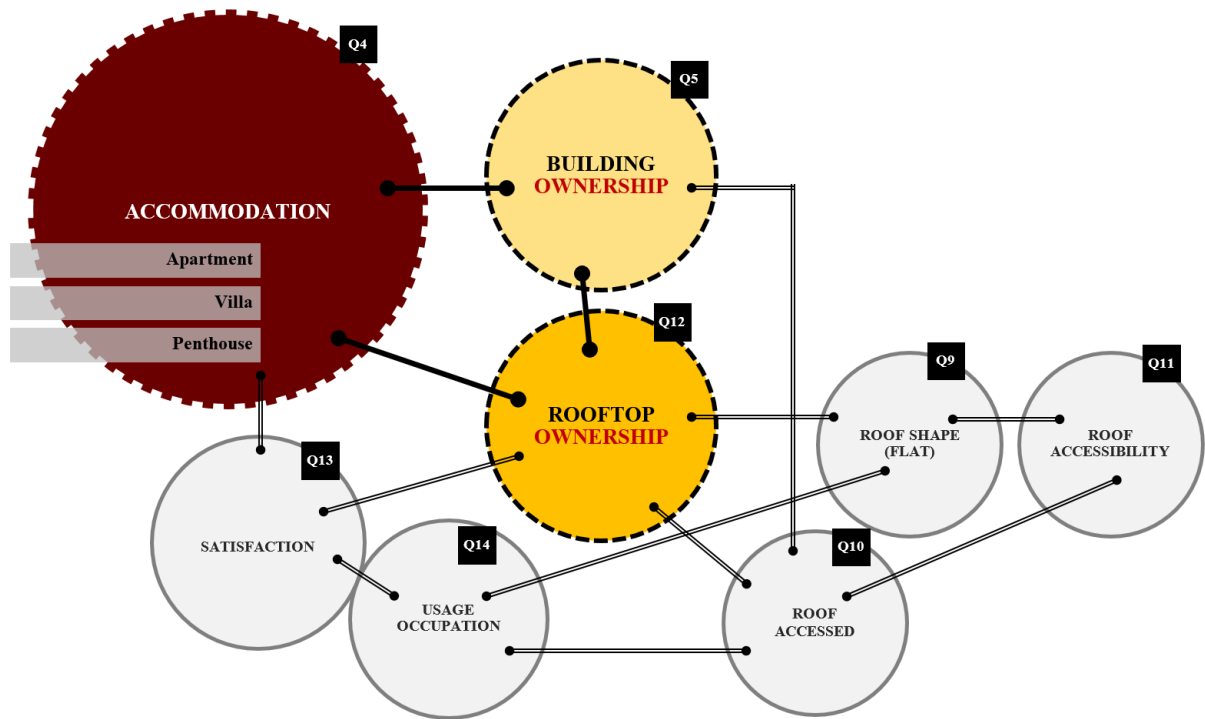


Figure 12. Relationship Diagram of the Major Effective Variables

Table 2. Cross-tabulation_ Roof Accessed vs Accommodation Frequency and Percent

		Q10: Roof Accessed		Frequency (N)	Total Percent (%)
Q4: Accommodation	APARTMENT	Valid	YES	67	97.1
			NO	2	2.9
			Total	69	100.0
	VILLA	Valid	YES	29	93.5
			NO	2	6.5
			Total	31	100.0
	PENTHOUSE	Valid	YES	34	100.0
			Total	34	100.0
					Lowest Percentage

Later, descriptive analysis, ANOVA, and independent sample T-tests were conducted to test and differentiate between significant variable groups. The main aspects taken into consideration are the type of accommodation, building ownership, and current rooftop ownership, and their reflection and effect on the activities occupying the roof. As a starting point, referring back to the concluded frequencies, calculated in table 1, the researcher needed a clearer breakdown of rooftop access in relation to the type of accommodation.

Table 2, shows the percentage accessing the rooftops from each type of accommodation. It is clear that roof access is directly related to roof shape and accessibility. Residents who had no access to rooftops, referring back to table 1, are those who had no flat roof, therefore, they had

no leisure to access and use their roof. Those residents live in either apartments or villas, where roof design differs. However, all residents, who live in penthouses, had the luxury to use and access the rooftop. This point sheds light on the uniqueness of penthouses when talking about rooftops.

Another main variable for testing was rooftop usage occupation across different the different types of accommodations. This question helped map different rooftop patterns of use. Uses varied ranging from services, unused furniture, storage spaces, zoned activities, and empty unused spaces. To test this observation, the researcher conducted an ANOVA test, using the responses collected from participants, to check if the type of accommodation is a factor that could affect rooftop usage

occupation. The variable is significant when its confidence level (CI), significance, is 95% (significance less than 0.05), according to the range permitted for behavioral sciences [16]. Table 3 shows the means and the outcomes reached from the ANOVA test. The test shows that most roof usage occupations are significant, meaning that the variety of uses stated varies according to the type of accommodation. Unused furniture and empty unused spaces are the only insignificant uses meaning that there are no major differences in usage occupation among the different accommodations. Figure 13 presents samples of different residential rooftop patterns of use in New Cairo.

From this point, the researcher mapped an additional relationship between the building’s ownership and the current rooftop ownership versus the type of accommodation, as shown in figure 14. Ownership, either building or rooftop ownership, is defined as being owned by a single family or by multiple families. Living in an apartment or penthouse, the building is owned by multiple families, unlike the villa, owned by a single family. This major difference in accommodation directly affects the ownership of rooftops and thus affects the uses and

activities added and created on the roof. Roofs of apartment buildings are owned by multiple families, where there is no defined user, unless the property owned is a penthouse, where the roof is a part of the property itself. However, since villas are of a single owner, the owner of the roof is defined. This major identification maps the idea that ownership is a major factor that could affect the patterns created on the residential rooftops.

As tested and discussed later in the paper, multiple roof ownership found in apartment buildings shows that services and empty roof spaces count the most occupied patterns of use found on rooftops. These patterns ensure the negligence of using rooftops since there are no defined users, consequently, less degree of identity and sense of control towards the roof. Thus, the individual’s satisfaction towards rooftop is the least, refer to table 5, among the other types of accommodation, where roof is of a single owner. The more the space is owned by multiple owners, the less the individual feels the sense of freely controlling and using the space. To ensure the idea is stated, further tests are conducted.

Table 3. ANOVA Test_ Differentiate Roof Usage Occupation in Different Accommodations

Q14: Rank Usage Occupation	Mean			Significance
	Apartment	Villa	Penthouse	
Services (satellites, water tanks, etc.)	3.78	2.93	2.58	.000
Unused Furniture	1.43	1.80	1.76	.145
Storage spaces (enclosed area)	3.14	3.48	3.58	.018
Zoned Activities (enclosed living area, social gatherings, dining, animals/bird’s husbandry, etc.)	2.95	3.03	3.91	.017
Empty Unused Space	3.68	3.74	3.14	.092
Range: (1) Least Occupied → (5) Most Occupied				Significant < 0.05



Figure 13. Samples of Residential Rooftop Patterns Use in New Cairo (Author, 2021-2022)

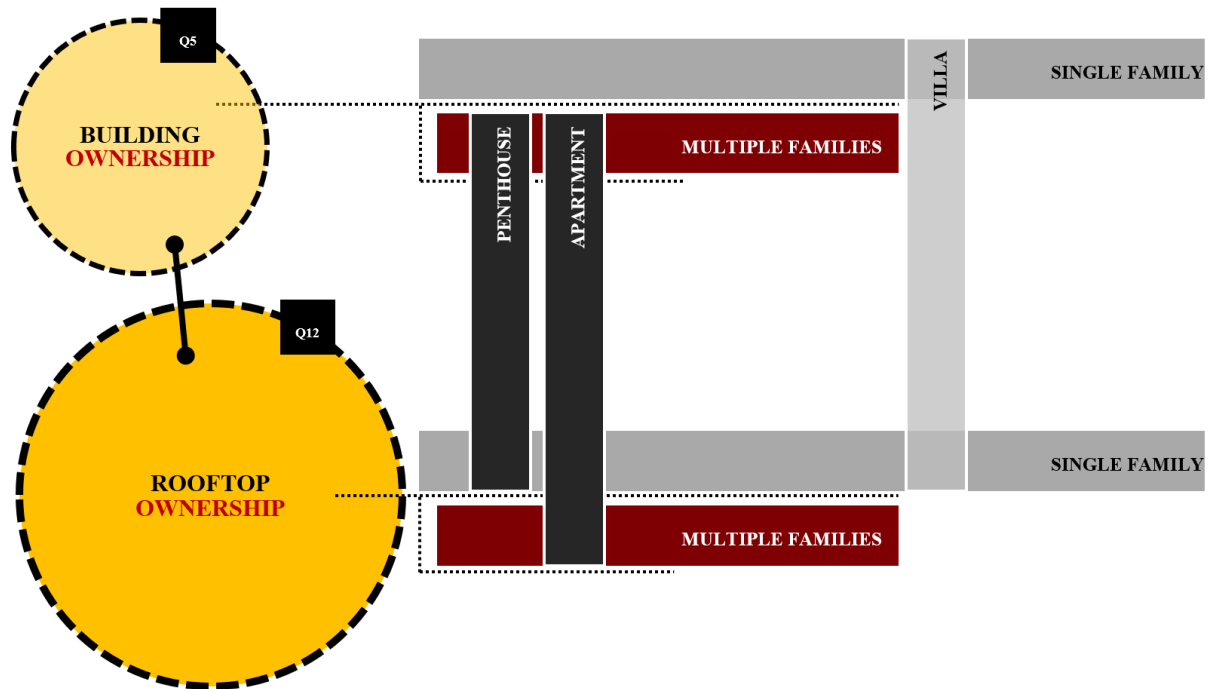


Figure 14. Building Ownership and Rooftop Ownership Versus Accommodation

To have a clearer vision of the impact of ownership, a descriptive group statistic is calculated between the types of accommodation, the current rooftop ownership, and roof usage occupation. Table 4 presents the mean values according to each accommodation. The more the mean is moving towards 1, the less the use is occupied; the more the mean is moving towards 5, the more the use is occupied. Unused furniture marks the least roof usage occupation among all types of accommodations. In apartment buildings, the most use occupying the roof are services, including satellite dishes and water tanks, which is logical since there is no specified space for these services rather than the roof and there are a number of residents living, hence it is logic to have the most roof occupation lying under services. Unlike apartments, the empty unused space occupies the most in villas. The outcome is logical since villas already have storage spaces and a garden to accommodate activities, therefore, roofs could be an empty space. However, this is variable according to the villa design; some villas in New Cairo had green areas, swimming pools, and gathering spaces on the roof. This could be due to the outdoor area offered and designed. Zoned activities, including enclosed living areas and social gathering spaces for instance, mark the most occupation in penthouses. Penthouses, as mentioned previously, are roof dwellings. The penthouse is a valuable property which new developers started focusing on for resale. The roof, for a penthouse, is somehow like the balcony in apartments. It is the outdoor space part of the property. Therefore, penthouses get the most beneficial use of the roofs unlike the other types of accommodations, which referring back to table 2, all participants living in penthouses have access to and use rooftops.

The other variable tested is the resident's current rooftop satisfaction. Referring back to the literature discussed, when the number of people owning a space increases, the interest in using the space decreases. To test significance, the researcher conducted an ANOVA test to differentiate between rooftop satisfaction levels in different types of accommodations. Table 5 shows the means calculated and the significance found across the different accommodations for the user's satisfaction. The more the mean is towards 1, the more the user is unsatisfied; the more the mean is towards 5, the more the user is satisfied. As mentioned, residents living in penthouses tend to use the roof as part of their house, therefore it is logical to have those residents more towards being satisfied. However, apartment residents tend to be more unsatisfied since the individual has no defined space to have full care and control of, creating a roof full of services and leftovers. Villa residents are more towards being neutral which supports the idea that villas have other spaces, such as the garden or basement, that could accommodate various activities. Therefore, the residents deal with the roof as a clean and empty space that could accommodate activities or events occasionally or permanent activities when the outdoor areas offered in design are limited. Consequently, referring back to the factor this research is testing, ownership has a direct impact not only on the patterns of use created on rooftops, but also on the resident's satisfaction. The T- test, shown in table 6, ensures that the more the roof owner is defined, as a single owner (as in villas and penthouses), the more the resident is towards being satisfied with the current rooftop design, unlike having multiple rooftop owners (as in some apartment buildings), where the resident is more towards being

unsatisfied.

With the different properties having roofs owned by a single resident, a T- test is conducted to test whether user satisfaction differs between residents living in villas and others living in penthouses; analyzing whether the same level of ownership could also have a direct impact not only in the roof patterns of use, but also in the tenant's satisfaction with rooftop design. Table 7 presents an independent sample T-test between single roof ownership

and current rooftop satisfaction. Results showed that there is a significance meaning that there is a difference in user satisfaction level between residents of villas and penthouses. Residents of penthouses tend to be more satisfied than those living in villas, which ensures previous results presented, concluding that users living in penthouses have a greater vision towards beneficially using rooftops; as they consider the roof an outdoor space part of their house.

Table 4. Group Statistics_ Accommodation vs Roof Usage Occupation and Roof Ownership

		Q14: Rank Usage Occupation	Q12: Current Ownership Condition of the Rooftop	Frequency (N)	Mean
Q4: Accommodation	APARTMENT	Services (satellites, water tanks, etc.)	MULTIPLE	69	3.78
		Unused Furniture			1.43
		Storage Spaces (enclosed area)			3.14
		Zoned Activities (Enclosed Living area, social gatherings, dining, animals/bird's husbandry, etc.)			2.95
		Empty Unused Space			3.68
	VILLA	Services (satellites, water tanks, etc.)	SINGLE	31	2.93
		Unused Furniture			1.80
		Storage Spaces (enclosed area)			3.48
		Zoned Activities (Enclosed Living area, social gatherings, dining, animals/bird's husbandry, etc.)			3.03
		Empty Unused Space			3.74
	PENTHOUSE	Services (satellites, water tanks, etc.)	SINGLE	34	2.58
		Unused Furniture			1.76
		Storage Spaces (enclosed area)			3.58
		Zoned Activities (Enclosed Living area, social gatherings, dining, animals/bird's husbandry, etc.)			3.91
		Empty Unused Space			3.14
Range: (1) Least Occupied → (5) Most Occupied		Lowest Mean		Highest Mean	

Table 5. ANOVA Test_ Differentiate Current Rooftop Satisfaction in Different Accommodations

Q4: Accommodation	Q13: Current Rooftop Satisfaction	Mean	Significance
Q4: Accommodation	Apartment	2.71	.000
	Villa	3.00	
	Penthouse	3.85	
			Significant < 0.05

Table 6. Independent Sample T-Test_ Current Rooftop Satisfaction vs Current Rooftop Ownership

	Q12: Current Ownership Condition of the Roof	Frequency (N)	Mean
Q13: Current Rooftop Satisfaction	Single	65	3.44
	Multiple	69	2.71

		T-Test for Equality of Means		
		t	df	Significance (2-tailed)
Q13: Current Rooftop Satisfaction	Equal variances assumed	3.224	132	.002
				Significant < 0.05

Table 7. Independent Sample T-Test_ Single Roof Ownership_ Accommodation vs Current Rooftop Satisfaction

	Q4: Accommodation	Frequency (N)	Mean
Q13: Current Rooftop Satisfaction	Villa	31	3.00
	Penthouse	34	3.85

		T-Test for Equality of Means		
		t	df	Significance (2-tailed)
Q13: Current Rooftop Satisfaction	Equal variances assumed	2.723	3.00	.008
				Significant < 0.05

5. Discussion

Focusing on the privilege of having a massive number of flat roofs around, the researcher was looking forward to understanding the main factors, mainly ownership and the variables behind, that led Cairenes to use rooftops the way it is seen around. By understanding the factors that led to the surrounding rooftop patterns of use, designers could change how skylines look like. Referring back to the results reached and analyzed and the literature review discussed, ownership shows a direct impact on the patterns of use on residential rooftops in New Cairo, the chosen case study. Roof shape, access, and accessibility are direct primary factors that enable users to have the option of using rooftops. However, the key finding of this paper is that ownership is the indirect main factor that shapes the way residents use and perceive the roof. As stated in literature, the more the ownership and territoriality of the space are defined, the more the users have full control over the space, therefore, an organized and planned space is created.

Different types of accommodation affect the degree of ownership, whether single or multiple. Variables were tested in relation to the different types of accommodations (apartment/ villa/ penthouse) which internally reflects on ownership. Ownership was tested in relation to a number of factors including patterns of use and residents' satisfaction with rooftop design. Results ensure that ownership affects the way and behavior people use the space as well as their

perception of the roof. According to the outcome reached, the type of accommodation that best shaped the rooftop in New Cairo is the penthouse. Residents living in a penthouse perceive and use the roof as an outdoor space that accommodates daily activities; considered a part of the residential unit. This idea refers back to the way Ancient Egyptians used to use their roof as a primary space of their house, where the user owning the roof was defined. Therefore, penthouse residents fully and beneficially use the rooftop, creating a positive perception and satisfaction towards rooftop design.

Some new developers started valuing rooftops by designing and selling penthouses, creating a private and spacious residential unit with an outdoor breathable space part of the house; the roof. The results of this paper provide evidence that most architects and urban designers deal with roofs as the enclosure surface that has no defined use. Currently, there is a need to develop residential rooftop design concepts, ideas, and principles. This study tried to highlight the vision of reusing rooftops beneficially taking into consideration ownership as a main factor that defines all aspects shaping the rooftop of residential buildings.

6. Conclusions

This research aim was to test and analyze the impact of ownership and how it could affect the patterns of use found on rooftops. New Cairo was the selected area of research,

where a total of 134 residents participated in the study. Different types of accommodations, resulting in different levels of ownership, were included to test the impact of ownership and how it could affect a number of factors some of which are the user's satisfaction and the way tenants use their residential rooftops. Literature review, data collected, and outcomes and results reached all support the idea and the research argument that ownership is an important factor, could be considered the main, highly affects the behavior and the way an individual uses a space, here residential rooftops. Whenever a space is owned by multiple users, an individual is less likely to have full control over the space, resulting in undefined patterns of use, less satisfaction, as well as less concern and interest in using the space.

For Cairenes, it is a privilege to have flat roofs marking a large area covering the city. Ensuring the research gap, many people are still not using rooftops or even getting the most use of rooftops. In this paper, the results reached from relative literature and the quantitative analysis showed that rooftops are seen as an overall unresolved space that is in need of more design considerations. Not only residents, urban designers, developers, and scholars need to address and have a new vision towards roof usage, especially residential rooftops, considering rooftops as valuable urban elements in need of enhancement and usage. Flat roofs are spaces that require more concentration. As a bachelor student, teaching assistant, and a researcher, students are in need of more exploration and consciousness towards using and designing rooftops. This tends to help future research as well as project developers and designers to include rooftops, especially flat roofs, in the overall design concept process. This could help create generations thinking of urban transformation and seeking for a better change; hence, looking from up-high downwards, the image created will well present the city and its people. Each city speaks up about itself through its architecture and its people.

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