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Chapter

Rethinking the design of vertical green spaces in the post-pandemic era: visitor behaviour and real-life cognitive experience at Crossrail Place, London.

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Abstract

The COVID-19 pandemic has profoundly impacted public spaces in cities worldwide, posing challenges in creating enjoyable, usable, and safe environments in high-density urban areas. Vertical urban spaces, such as roof gardens, have emerged as significant components of cityscapes, offering unique qualities in location, accessibility, and experience. This chapter investigates the Crossrail Place roof garden in Canary Wharf, London, through direct observation and 44 semi-structured interviews conducted before, during, and after the pandemic. The research explores critical aspects of vertical spaces, including accessibility, circulation, activities, design challenges, security, and safety. Findings highlight human behaviours, areas for improvement, design strategies, and the need for flexible regulation in these spaces. The chapter also examines the potential increased demand for vertical public spaces in the light of future pandemics and travel restrictions. This evidence is crucial for policy makers, urban designers, landscape architects, and government organisations to recognise the importance of vertical urban spaces in future city planning.

Keywords: *roof garden; vertical public realm; COVID-19; social resilience, London*

1. Introduction

The beginning of this century is characterised by a dramatic rise of urban populations and urban development globally. This 'urbanisation' has been more a movement of population to cities than just an arithmetical growth of population. Indeed, more than half of the world has been living in cities since 2007, according to the World Urbanisation Prospects 2014 of the United Nations (Desa, U.N., 2015). This equates to 54% of the world's population residing in urban areas and this is predicted to increase to 66% by 2050, meaning more than six billion people will live in cities. This growth is equivalent to around 1.4 million additional people each week (Leeson, 2018; Oldfield, 2019).

Lawson (2010, p.292) in identifying the impact of this, states that: "The higher the density, the harder we have to work to design our cities in such a way that makes them pleasant and fulfilling places to live." Indeed, the main challenge of urban design today is to create a functional, sustainable urban space with the ability to accommodate and respond to diverse, intense, hybrid, dynamic, and unprecedented urban conditions (Cho et al., 2015; Pozoukidou & Chatziyiannaki, 2021). Eventually, the ways of understanding design and the utilisation of sustainable urban spaces requires both quantitative and qualitative reconceptualization. This requires a challenging of and reassessment of all previously existing and traditional notions of density, space, typology, and publicness, among others, in the context of high density, high-intensity urban environments. While conventional forms of public spaces and their timeless values remain immensely important, new ways of attaining and sustaining such values, as well as investigating possible new values and modes of publicness, in high-density conditions, are very crucial for a vibrant city (Cho et al., 2015; Lehmann, 2016).

A significant challenge in ensuring a safe environment during recent or future pandemics is spatial density. As the future of public space creation is contemplated, several questions arise, including the capacity of such spaces and the manner in which individuals co-occupy them (Megahed & Ghoneim, 2020). In 2020, even park benches were taped over to prevent groups of people from sitting on them. As COVID-19 restrictions eased in 2021, institutions ranging from intimate jazz clubs to expansive outdoor sports arenas, maintained infection-prevention measures, often more stringent than standard Fire Department regulations, with the risk of closure for noncompliance. In Spain, Italy, and France during 2020, residents creatively adapted apartment balconies to engage with others, fostering a collective "hive" of vertically arranged micro-spaces, where they maintained social distancing while sharing experiences (Gupta, 2020). This three-dimensional social interaction encompassed daily life, familial support, greetings, and cultural entertainment. Consequently, balcony spaces proved vital for mental well-being, transcending their utilitarian purpose (Pouso et al., 2021; Peters & Halleran, 2021). Reflecting on lockdown experiences, it becomes evident that public space design should not only prioritize enjoyment but also address acceptable density levels during hazardous times. Striking this balance allows for pleasurable experiences while maintaining necessary social distancing measures.

Vertical green social spaces, predominantly privately owned and managed, are increasingly presented as 'public' spaces. These hybrid spaces represent an emerging typology of public space, exhibiting characteristics and regulations distinct from conventional models of public open spaces, such as public squares and parks (Hadi et al., 2018; Childs, 2006). Evolving hybrid urban spaces comprise elevated spaces and multi-level spaces, encompassing pedestrian bridges, roof gardens, sky courts, and sky parks (Oldfield, 2019; Cho et al., 2015). A considerable number of developers have neglected to acknowledge the potential of these spaces in augmenting amenities, well-being, productivity, social interaction, and revenue, often excluding them for cost-saving purposes (Pomeroy, 2013; Lehmann, 2016). Pomeroy (2013) further underscores that city governments can mandate such spaces as a condition of planning approval for major buildings, offering incentives like increased permitted height, supplementary parking spaces, and decreased property taxes. This approach is employed in Singapore, using a 'LUSH Index', a technique for quantifying the amount of green private and public space, as well as green façades provided by the developer (Timm et al., 2018).

Singapore has become a global exemplar in embracing the concept of vertical urbanism. The integration of sky-gardens and vertical social communal spaces is now an essential consideration in the development of new Singaporean high-rise buildings. Notably, sky-gardens pervade both Housing and Development Board (HDB) and private high-rise residential constructions (Pomeroy, 2012; Oldfield, 2019; Samant, 2019). The emergence of high-rise designs incorporating 'mixed-use' elements, such as shopping malls, residential units, workplaces, entertainment venues, and sky-gardens within a single edifice, is increasingly observed in numerous Western cities, including London and the United States (Viñoly et al., 2015; Al-Kodmany, 2018). These spaces have been well-established in many Asian cities throughout the majority of the 21st century. The expansion of public space offerings represents a marked shift from the conventional isolated high-rise structures, which are characterised by high-security, closed entrances, uniform single-purpose floors extending skyward, and a 'crown' discernible only from a distance (Li et al., 2022; Samant & Menon, 2018).

The phenomenon of vertical garden spaces has been rigorously examined and assessed by the authors through a variety of distinct programmes, encompassing recent endeavours in London. The research has focused on three diverse projects: Sky Garden (high-altitude, interior garden, situated at 20 Fenchurch Street), The Garden at 120 (mid-elevation, outdoor garden, also located on Fenchurch Street), and Crossrail Place (elevated yet low-rise, semi-indoor, semi-outdoor, based in Canary Wharf). The study has meticulously surveyed and analysed these initiatives with regard to the design and utilisation of vertical green communal spaces, as well as their ramifications on human behaviour, physical and psychological well-being prior to, during, and subsequent to the Covid lockdown.

The successes and failures of vertical garden spaces are reliant not only on the building design. They put responsibility on building owners and operators, to provide a balance in how such spaces are governed; provide the necessary security for protection of the building users and

residents; and retain benevolent intentions of allowing public freedom and more flexible rules to motivate social interaction (Hadi et al., 2018; Samant & Hsi-En, 2017). This emphasises the need for guidance and regulations on how sky-gardens and communal spaces are used and operated as places of community and social interaction. Questions do, however, remain about the hierarchical level of privacy, safety, over-bureaucratisation, and inclusiveness of the varied types of vertical public spaces arising from this mixed configuration (Oldfield, 2019; Cho et al., 2015).

1.1. Case study: Crossrail Place

This chapter focuses on the analysis of the Crossrail Place roof garden in Canary Wharf, London. This project was chosen due to its unique nature in terms of location, accessibility, design, management, and activities. Crossrail Place roof garden is around 10000 square metres of roofed and elevated park above the new underground route of the Elizabeth Line. The species of plants and their positioning in the 300m long park references the geography and history of Canary Wharf (Bosetti, et al., 2019). The Canary Wharf Group aimed to create a community park that could be used through all seasons of the year and the developers agreed with the local authority to build a public roof garden over the top of underground station, to compensate for the lack of green leisure opportunities in the London Docklands area (PLACE & WHARF, 2016) (Figure 1 and 2).

The roof garden has direct access from the street level through a sequence of escalators and it also has two public elevators that take the visitors directly to the roof garden level. The roof garden is covered with a complex ETFE vaulted lattice timber roof that encourages daylight penetration and natural irrigation. Besides the green landscaping, there is a pub, restaurant, and an amphitheatre within the park. Crossrail Place is free to visit without pre-booking and it is open to the public from 09:00am to 09:00pm. The Crossrail Place roof garden is managed to the same rigorous standard as the rest of Canary Wharf estate. Indeed, the Canary Wharf security management plan was approved by the London Borough of Tower Hamlets to “prevent crime and fear of crime”. The plan also states that there will be “no smoking and no consumption of alcohol” (except in the pub), and that the park will be “closed in the evening”. The original intention was to close the park at sunset, but the popularity of the pub and the restaurant have resulted in a change to now close at midnight. There is also “comprehensive CCTV coverage” and monitoring is undertaken from Canary Wharf’s control room, with images “saved for a defined period” (Bosetti, et al., 2019).

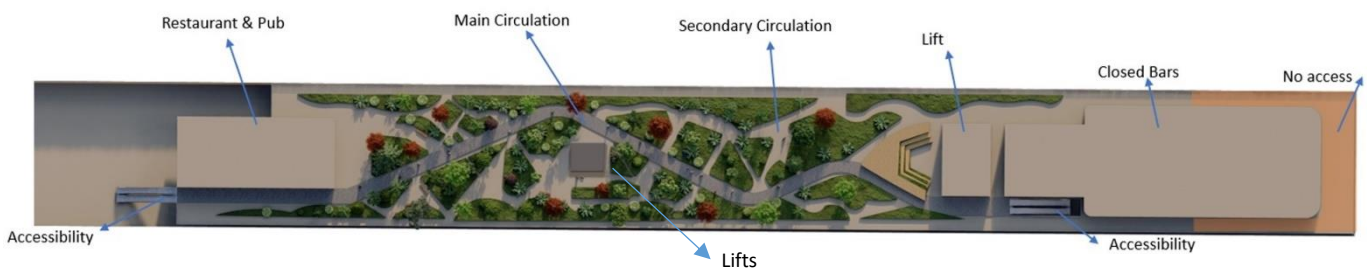


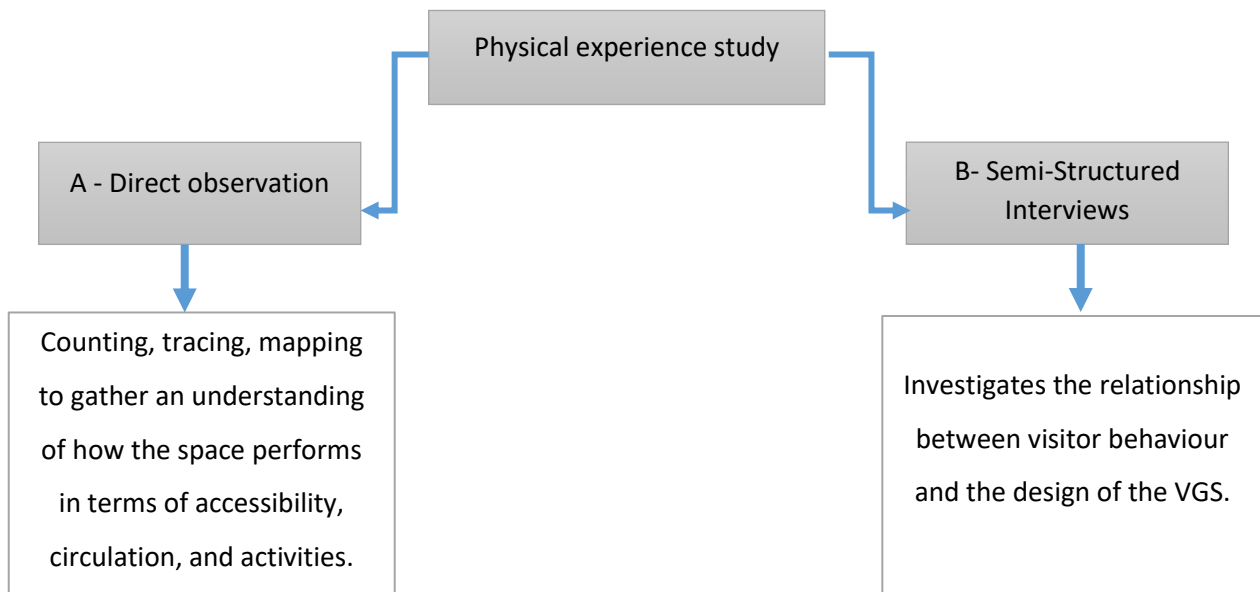
Fig.1. Crossrail Place Roof Garden Layout, Canary Wharf, London. Source: Author's Digital Model.



Fig.2. Crossrail Place roof garden, Canary Wharf, London. Source: Author.

2. Methodology

The purpose of this study was to explore how people are using vertical green social spaces before, during, and after the Covid19 pandemic. The specific objectives were to analyse the real-life cognitive experience of Crossrail Place visitors and to examine critical issues such as accessibility, circulation, activities, limitations of visitors, and social distancing. The method used in this study is a mixed approach as one tool on its own may not have provided all of the answers.



2.1. Direct observations

The first method used in this study was direct observation at different times over a three-year period (2019-2022), inspired by and following Jan Gehl's method for studying public life (Gehl & Svarre, 2013; Gehl, 1989). Fieldwork of 'before, during, and after' was essential for data collection, to gather an understanding of how the space was experienced and how it then changed in terms of accessibility, circulation, and activities. This method required observation and data collection from 2019, before the pandemic, with many subsequent visits during the gradual relaxation of regulations, up to the present (2022). The author visited Crossrail Place many times to observe the layout and the users visiting the spaces (Table 1). All of the data collected was stored in a secure location in accordance with General Data Protection Regulation (GDPR) protocols.

Table 1: Data collection date and time.

Crossrail Place roof garden, Canary Wharf, London		
<i>Date</i>	<i>Time</i>	<i>Regulations</i>
Thursday, 26/12/2019	12:00- 15:00	Pre-Pandemic
Friday, 27/12/2019	10:00- 14:00	Pre-Pandemic
Saturday, 11/07/2020	16:00- 19:30	New rules with COVID 19
Sunday 18/10/2020	12:00- 16:00	New rules with COVID 19
Saturday 22/05/2021	14:30- 17:00	New rules with COVID 19
Sunday 23/05/2021	11:30- 13:00	New rules with COVID 19
Thursday 11/11/2021	14:00-17:00	Post- Pandemic
Friday 12/11/2021	12:00- 15:00	Post- Pandemic
Friday 31/12/2021	13:00- 16:00	Post- Pandemic
Saturday 03/07/2022	11:00-14:00	Post- Pandemic

2.2. Semi-structured interviews

The study aimed to investigate the relationship between visitors' behaviour and the design of vertical social spaces. To achieve this, semi-structured interviews were conducted to explore the cognitive and physical experiences of space users and the impact on social interactions that occur and the factors that facilitate them. These interviews are embedded within a phenomenological qualitative approach that focuses on exploring the lived experiences of participants to understand the meaning and essence of a particular phenomenon (Creswell, 1998; Peters & Halcomb, 2015). The phenomenological qualitative approach is particularly useful for delving into complex, multifaceted phenomena that are difficult to measure quantitatively. It enables researchers to capture the richness, depth, and complexity of human experiences, as well as to uncover new insights and understandings that may not be apparent through other research methods (Rivera et al., 2021; Loder, 2014). This method circumvents the influences of pre-established theories that may lack such direct observational study analysis.

The fieldwork took place in Crossrail Place roof garden, Canary Wharf, London. Participants were the visitors to the space and they were interviewed during the site observation study. The semi-

structured interviews were conducted with people from different age groups, however, all of the participants were aged 18 and over. The duration of each of the interviews was around 15 minutes. Forty-four interviews were conducted and analysed (n=44) with the memos written in form of written notes, reflections, and the organisation of themes were formed throughout the analysis process.

3. Results

3.1. Direct observation study results

The observational studies for the site analysis took place during weekends and weekdays to allow the direct and equal comparison with the four different conditions which are: 'pre-pandemic'; 'lockdown'; during 'pandemic'; and 'post-pandemic'. During official 'lockdown' the garden was totally closed, with no observation or data collection. The period of time referred to as 'pandemic' in this study is post-lockdown, when not everybody had been vaccinated, but limited degrees of relaxation for exercise, social meetings, and travel were permitted. 'Post-pandemic' is after the date that the government announced the relaxation of all regulations.

The pre-pandemic analysis shows that the average population during the hourly intervals did not exceed 45 visitors on weekends and 34 visitors on weekdays (Figure 3). The roof garden's peak-time population was during the lunch break period between 12:00pm to 14:30pm. The average time visitors spent in the roof garden was about 30 minutes during weekends and 20 minutes during weekdays (Figure 4). The analysis indicates that around 60% (n=24) of the visitors spent about 10 minutes walking in the garden's primary circulation area and enjoying looking at the different plants. The field observations revealed that 82% of the visitors spent around 10 to 15 minutes sitting in the garden after their physical walk in the roof garden. The analysis indicated that around 43.5% (n=17) of the people visiting the roof garden were adults (25-64 years), 30.5% (n=12) were youths (15-24 years), 15.3% (n=6) were children (00-14 years) and 12.8 % (n=5) were seniors (65 years and above).

The data collected during the pandemic period shows a significant increase in the number of people visiting the roof garden at one time. The average population per hour reached about 73 visitors on weekends and 50 visitors during weekdays (Figure 3). Further analysis indicates that the pandemic had a significant impact on the sharp increase in the number of visitors and also on the duration of stays at the roof garden. The average time visitors spent on the roof garden increased to 50 minutes during weekends and 35 minutes during weekdays (Figure 4). The results also revealed that there was also a massive increase in the number of youths and children visiting the roof garden during the pandemic. The analysis indicated that the number of youths (15-24 years) increased from 30.5% (n=12) pre-pandemic to 40.65% (n=25) during the pandemic. Moreover, there was an increase in the number of children visiting Crossrail Place from 15.3% (n=6) to 18.5% (n=11), especially during the weekend, when families were coming with their children (n=15) for a picnics at the roof garden.

On the other hand, the data analysis after the pandemic period shows a significant decline in the average number of visitors to Crossrail Place compared with the data collected during the pandemic. The average population per hour reached 54 visitors on weekends and 43 visitors on weekdays (Figure 3). The results indicate that the roof garden visitors' average population per hour decreased by 21% after the pandemic time, while it increased by 18.5% since the time before the pandemic. Moreover, the average time of stay in the roof garden has increased during the post-pandemic to reach 35 minutes during weekends and 30 minutes during the weekdays (Figure 4). The observation study results highlighted the increase of adults visiting the roof garden on weekdays during the lunch break. The results show that the number of adults visiting the roof garden has increased compared to the pre-pandemic period to reach 20 visitors per hour during weekends and 23 visitors per hour during weekdays. The post-pandemic observation analysis also shows a slight increase in the average number of children from 6 (pre-pandemic) to 8 (post-pandemic) and youths from 12 (pre-pandemic) to 16 (post-pandemic).

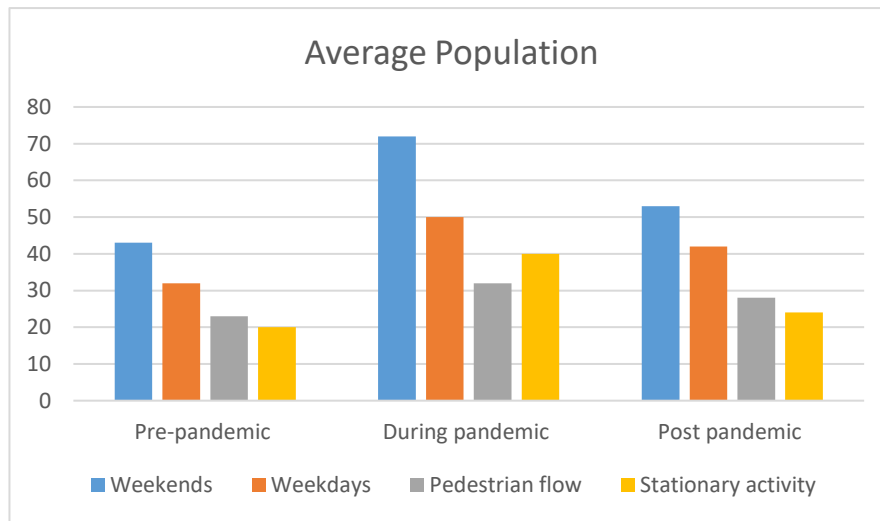


Fig.3. Crossrail Place roof garden visitor's average population. Source: Author.

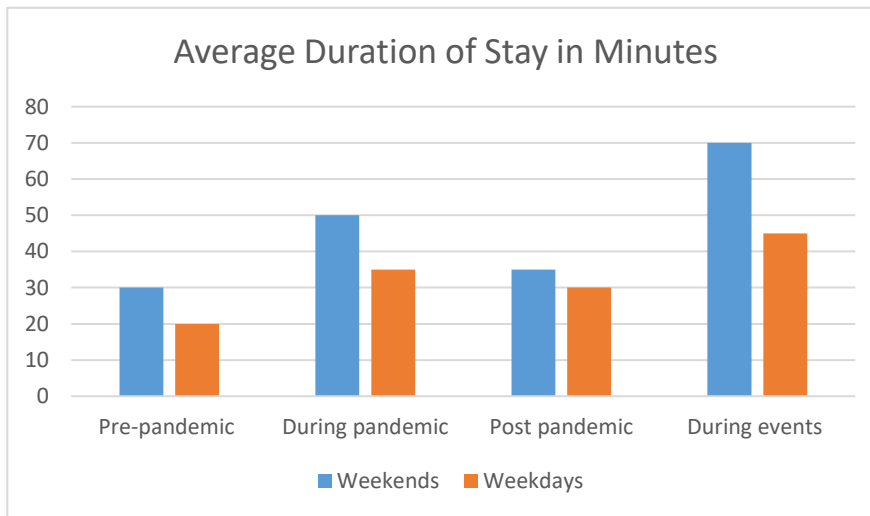


Fig.4. Crossrail Place roof garden visitor's average duration of stay in minutes. Source: Author.

The pre-pandemic observation study identified six different optional and social activities taking place in the roof garden. The main dominant activity taking place was walking, with visitors generally sauntering around the roof garden taking photos and looking at the plants. There were other people sitting with their friends on the wooden benches either having a conversation or eating and drinking. The results show that many of the people sitting and eating were workers from Canary Wharf, and that they preferred to have their lunch break in the roof garden. The amphitheatre was only used by a small number of people with a few families were sitting there. There was also a significant number of people passing through the roof garden to enter the bar or the restaurant. Although there was a vibrant movement in the roof garden there was a lack of social interaction with the only one being at the entrance of the roof garden where a public piano is located and some people were engaged either by listening to others or taking pictures (Figure 5 and 6).



Fig.5. Crossrail Place roof garden visitor's activities pre-pandemic . Source: Author.

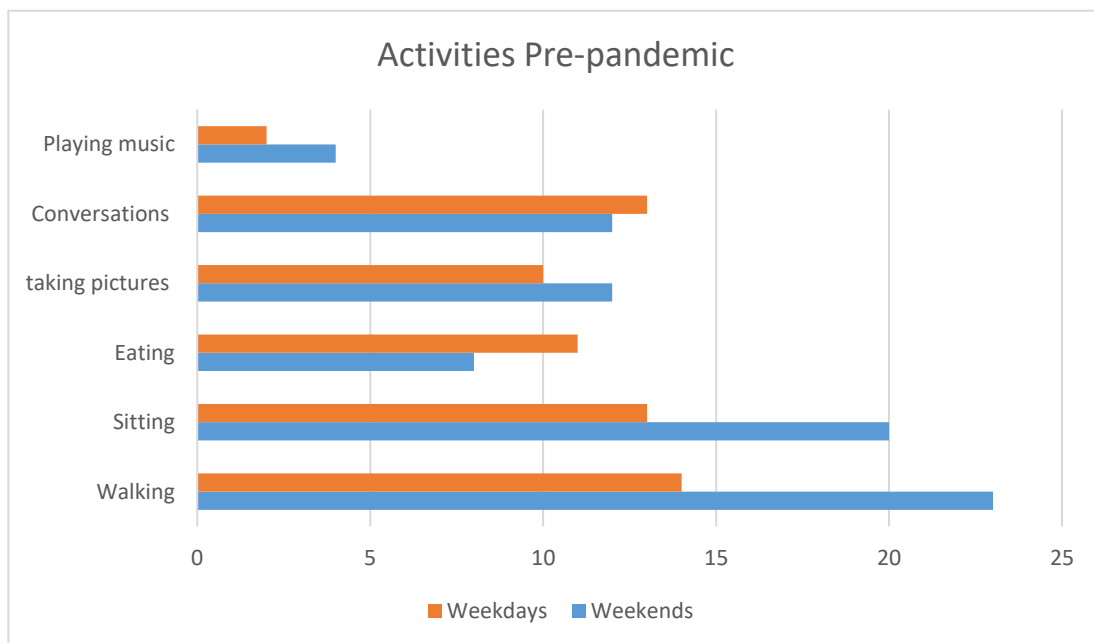


Fig.6. Bar graph for the average number of visitor's activities pre- pandemic. Source: Author.

The data collected during the pandemic investigated the presence of new activities taking place in the roof garden such as reading, relaxing, and playing. Some of the participants spent their time in the roof garden by themselves, sitting on the wooden benches near the plants, relaxing and reading their books. There were also short story stations with touch-free sensors newly placed in the roof garden to motivate people to read. The number of people sitting in the roof garden notably increased since the pre-pandemic period. There were more families and children coming to the roof garden for a picnic on the weekends. Also, children were playing and running in the roof garden and there was a new jumping game placed near the entrance of the garden. The roof garden visitors living in Canary Wharf were coming to Crossrail Place to meet their friends and they described the roof garden as “a safe place to meet friends and hang out in a green environment”. This was further discussed during the semi-structured interviews (Figure 7 and 8).

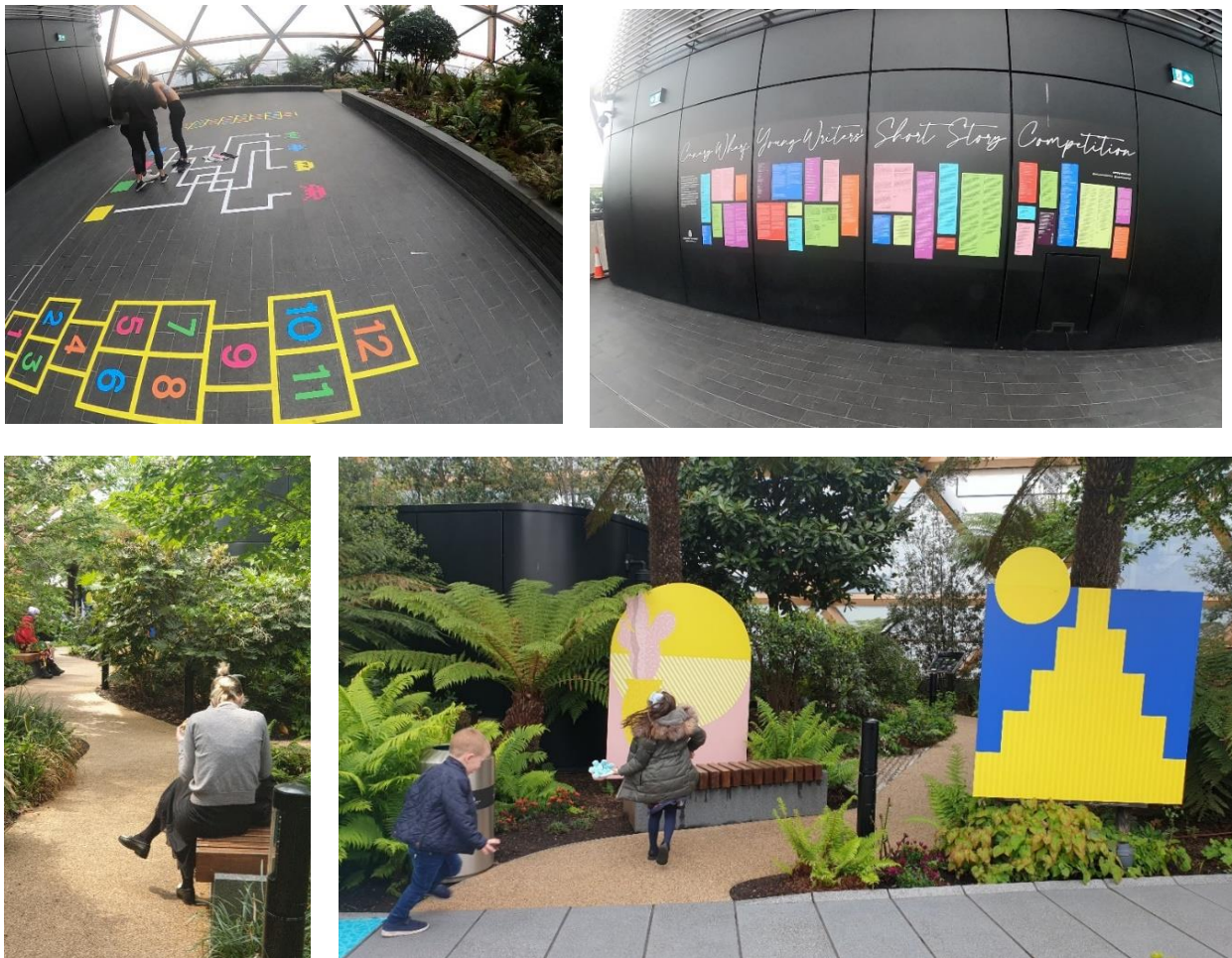


Fig.7. Crossrail Place roof garden visitor’s activities during the pandemic. Source: Author.

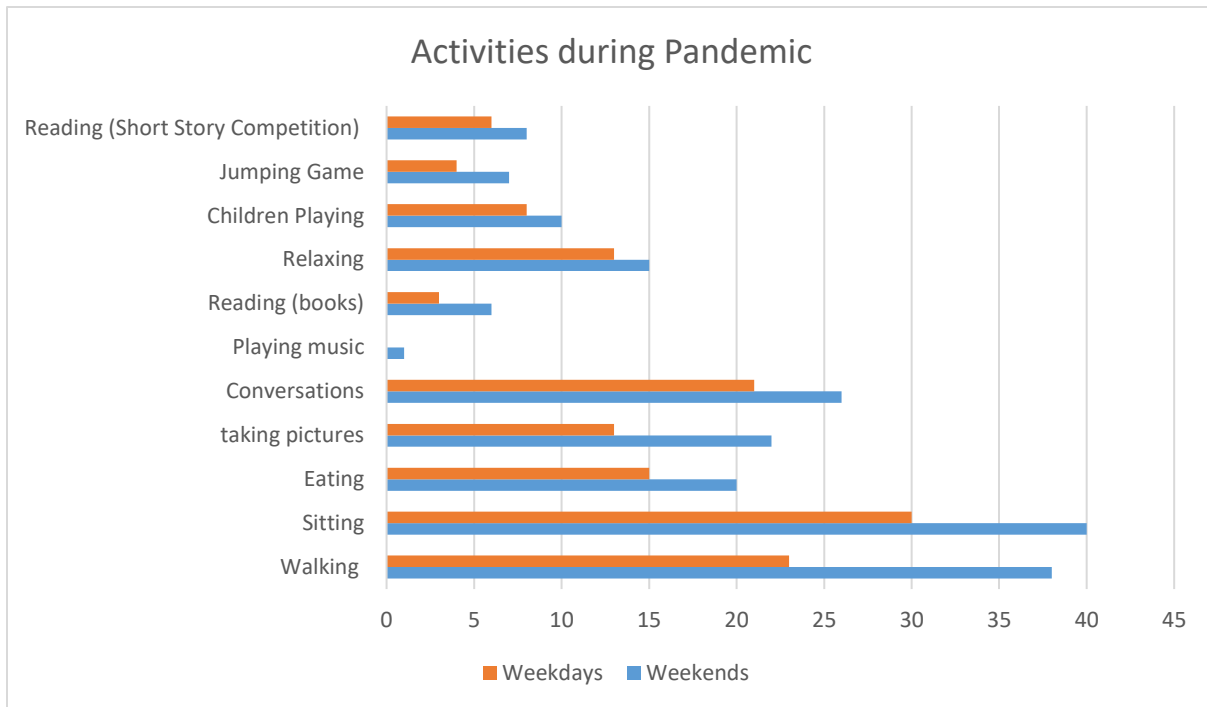


Fig.8. Bar graph for the average number of visitor’s activities during pandemic. Source: Author.

The data analysed from the post-pandemic period indicates that the roof garden activities and use have changed to become more active than during the pre-pandemic period. The short story stations have become more popular and are now ongoing attractions where the visitor can choose the length of the story, one, three or five minutes, and the dispenser will select a mystery story for them to read during their visit. The amphitheatre has also been open for performances and music events during the summer of 2022. The roof garden delivers a free ticket programme of festivals, performances, and music at the amphitheatre, which is known as “Bloom”. During these summer events, the roof garden reached its highest number of users, although during the normal weekday the space seems to be less active and vibrant compared with the pandemic period (Figure 9 and 10).



Fig.9. Crossrail Place roof garden visitor’s activities post-pandemic. Source: Author.

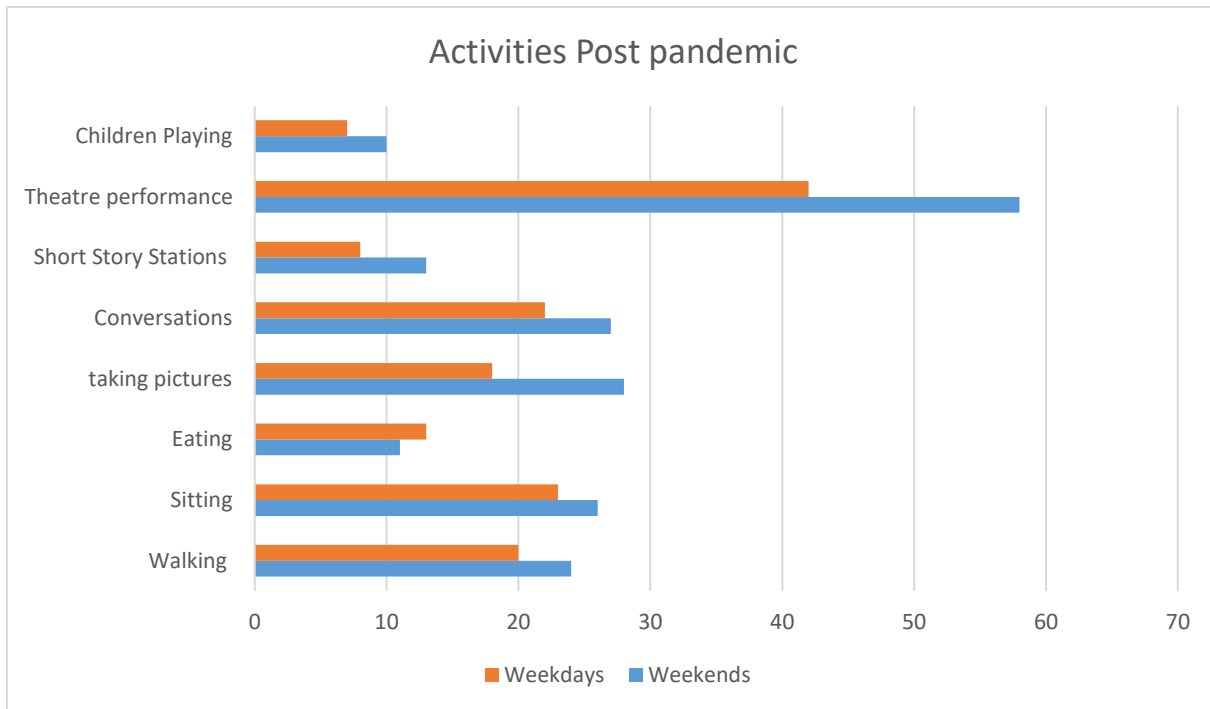


Fig.10. Bar graph for the average number of visitor’s activities post pandemic. Source: Author.

3.2. Interview Results

A total of 44 interviews were completed; 43.2% (19) were male and 56.8% (25) were female. The average age of participants was 30.3 years. Around 61.4% (27) of the interviewees were living or working in Canary Wharf, 25% (11) were living in London and, 13.6% (6) were tourists and just visiting London for a short time. The interview analysis focused on five overarching themes: the purpose of the visit; accessibility; design concerns; suggested design features & activities; and visiting experience.

3.2.1. The choice and the purpose of the visit

The most common reasons for visiting Crossrail Place identified by visitors were: ‘for resting and meditation’; ‘meeting a friend’; ‘lunch break’; ‘family picnic’; and that ‘it’s free to visit’. A significant number of participants liked the fact that the roof garden theme is frequently changing, encouraging them to re-visit the roof garden. Many participants stated that they are regular visitors to the roof garden, as they live or work within a short distance of Crossrail Place and some participants, working in Canary Wharf, take regular lunch breaks in the roof garden. Some other participants first knew about the roof garden from social media posts.

The majority of the participants stated that they would stay no more than one hour in the roof garden. 68% of the participants (n=30) had previously been to Crossrail Place. 36% of the participants were regular visitors to the roof garden and visit the garden on a weekly basis, while 45% (n=20) visit the roof garden monthly.

3.2.2. Accessibility

When asked about the accessibility to the roof garden, participants most commonly mentioned that it is accessible from the ground level through escalators but that it's not easy to find from the street level. Most of the participants who visited the roof garden for the first time stated that they dislike the lack of visual access and connection from the street level to the roof garden (Figure 11). First-time visitors also mentioned that they had to follow the posted signs or Google Maps to find their way up to the roof garden. Participants did, however, frequently mention that access to the roof garden is helped by the proximity to public transportation such as the newly opened Elizabeth Line, the Jubilee underground line, and the nearby bus stops. Analysis of the interviews also identified that most of the participants described the garden as an accessible place for people with special needs and wheelchairs, although there were some complaints about the lift positioning and the visual access of these to the surroundings.

“It wasn't that clear from the ground level. The accessibility was a bit confusing. If you don't know the place, you might need to use Google maps, so I would say you have to search for it a bit” (Male, aged 30 years, living in London).

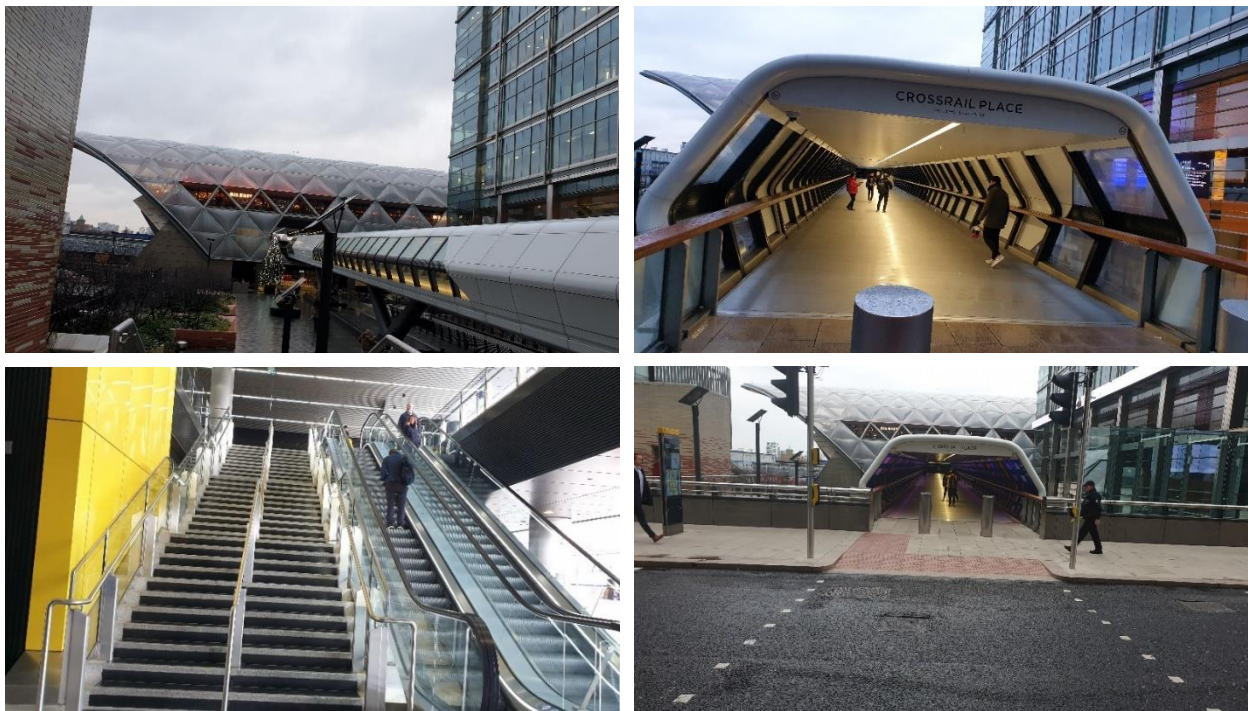


Fig.11. The Crossrail Place roof garden accessibility from the street level. Source: Author.

3.2.3. Circulation

Participants had mixed responses when asked about the roof garden's circulation. The most commonly mentioned response was that the curved pathways encourage the visitors to move around the roof garden and they give it a sense of enclosure and enable people to bond with the natural environment (Figure 12). Others mentioned that it's important for walking paths to be attractive, non-uniform, and to encompass shade and natural features. The garden's curved paths could, however, be confusing for first-time visitors. Participants commonly mentioned that the curved pathways are narrow for people to walk if there are people sitting alongside the paths. People sitting on the fixed benches also mentioned that they need more privacy as they felt their personal space was being encroached upon by people squeezing past as they walked around.

"I like the circulation and the curved paths make it feel more like a garden" (Female, aged 24 years, living in London).

"I think the circulation is good because it gives you a place to sit as well near the plants, although the walkways are a bit narrow" (Female, aged 28 years, living in Canary Wharf).



Fig.12. The Crossrail Place roof garden circulation. Source: Author.

3.2.4. Safety - COVID

The majority of participants (n=40) described Crossrail Place as a safe place to visit during the COVID-19 pandemic. Participants also liked the fact that the roof garden is well-ventilated and open, making them feel safe compared to other roof gardens in London (Figure 13). Numerous participants (n=18) also stated that visiting the roof garden during the pandemic had a positive impact on their mental well-being. A significant number of participants (n=24) stated that they would get dismayed when the roof garden was closed, and commonly mentioned that the roof garden should be open, even during a pandemic. A significant number of participants also mentioned (n=35) that they felt the need for more open-air and well-ventilated roof gardens in London. Participants frequently suggested that roof gardens have a positive future in London,

but they need to be well-integrated and managed by local authorities, not only the private institutions that manage the estate which includes the vertical garden spaces.

“...more of these spaces within the pandemic would be better. It’s better than a public park where everyone can just walk in; but here definitely, they can manage and control the number of people visiting the roof garden and set some rules to make sure everyone is safe” (Female, aged 28, living in Canary Wharf).

“...having spaces like this is something positive to the physical and mental wellbeing during the pandemic, as it’s private; people might want to get alone in a green space and feel safe” (Male, aged 35, working in Canary Wharf).

“Being in a green space is nice, it reminds me of not being in a city. ...public roof gardens especially in metropolitan cities are essential. ... they have a positive future ...they contribute to the mental wellbeing of all those who use it” (Male, aged 26, tourist from Spain).

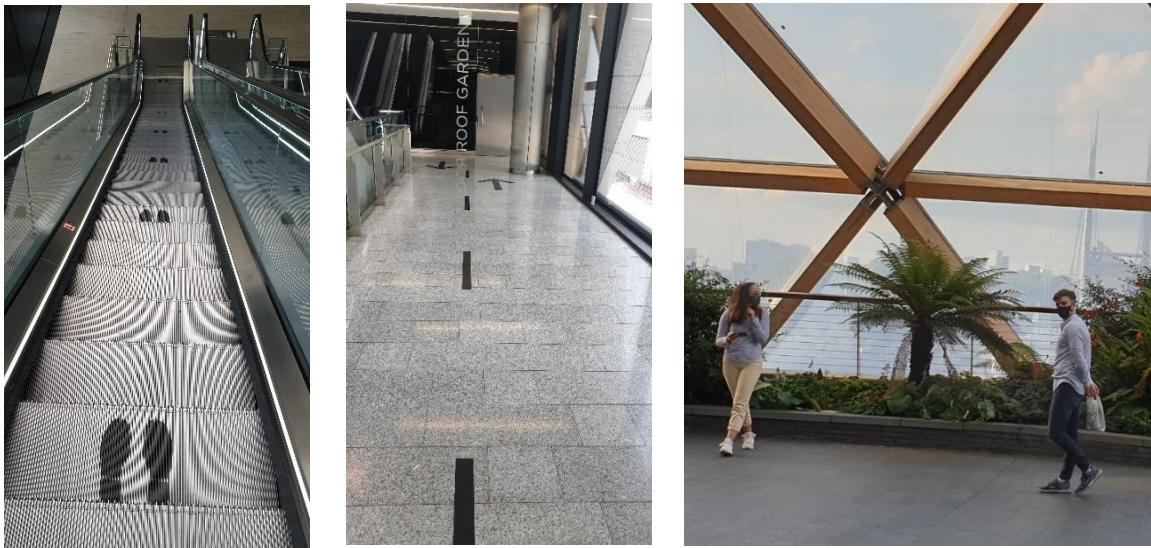


Fig.13. The Crossrail Place roof garden safety and social distancing rules during the COVID 19 pandemic. Source: Author.

3.2.5. Territorial rights

Visitors were asked to discuss the real level of territorial rights for the public in the roof garden compared to a genuinely public park or public footpath with long-established rights of access. London and other British cities are full of apparently public spaces which are, in reality, privately managed estates, such as the whole Canary Wharf district, and the ‘Freeports’ – in which the ‘right to roam’ is very tightly restricted. Hospitals, campuses, transport, business parks, and shopping malls are a few examples of publicly accessible spaces which are, in law, private estates.

Most participants (n=35) appreciated the fact that the roof garden is safer than most of London’s public parks due to the high level of security. Significantly, 41% of the respondents (n=18) stated that they are unaware of roof garden rules and restrictions and of the legal distinction of the roof

garden as a truly public or private space. This could imply that the management has been successful in avoiding obtrusive signs and noticeboards.

Other participants (n=10) recognised the garden as a private space and raised the issue that they cannot do some activities they are used to being able to do in public parks (Figure 14). A significant number (n=10) understood the roof garden as a quiet green place to rest and relax but they accepted restrictions on freedom to do activities such as walking dogs, picnicking, sleeping, photography, cycling, ballgames, busking, lighting fires, skateboarding, and playing loud music.

“It’s more private and it gives you a sense of security. I mean it’s more secure, there are restaurants and people walking around; even if you come at night, it’s fine but then compared to a park ... a public park might be a bit scary, especially during late evening time” (Female, aged 25, living in Canary Wharf).

“I cannot do the same activities if I compared this with a public park like Hyde Park. We cannot go for a picnic here, sit in the grass with our dog and listen to music” (Female, aged 28, living in Canary Wharf).

“I know that it’s private property and I would say that most people don’t know that this is private property. I am aware of things; like actually you can be accosted by the security guards for taking photos. You can still take them, but you have to be careful as most people don’t know that this is private property and it has its own security rules. I don’t think there is any reason though that anybody would feel particularly constrained” (Female, aged 66, living in London).

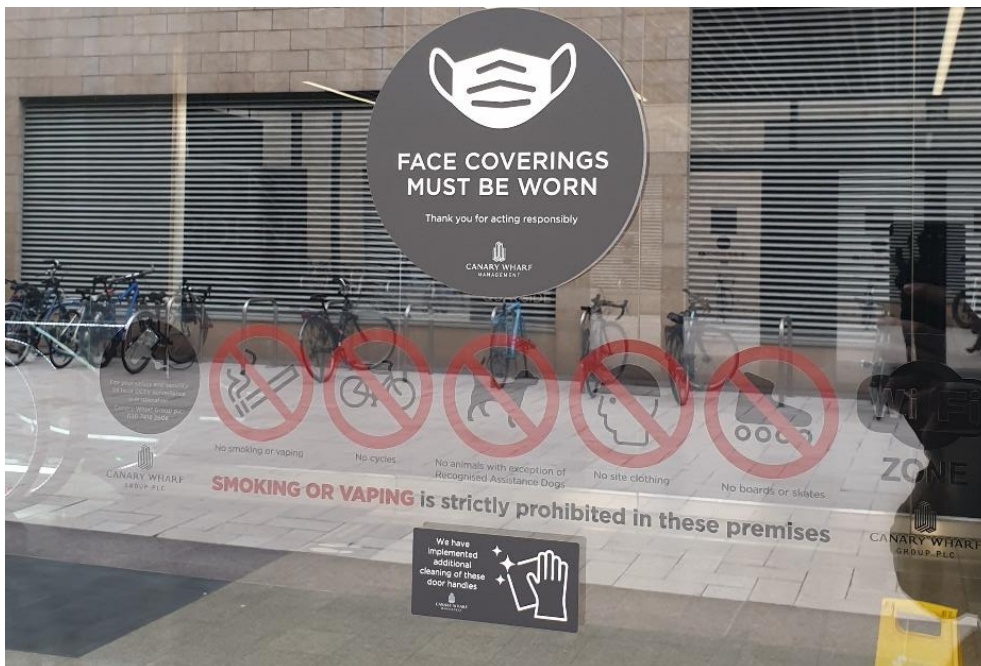


Fig.14. The Crossrail Place roof garden list of rules and restrictions, source:

3.2.6. Activities

Participants primarily reported using the roof garden for walking, socialising, eating and drinking, taking photos, and enjoying the green environment. Indeed, “*relaxing in a safe and green environment*” was the preferred roof garden-based activity for most participants. The majority of the participants living or working in Canary Wharf highly valued the roof garden as a place for eating and relaxing during their break times. The participants, living or working in Canary Wharf, also highlighted that the roof garden benefits from being centrally located in a place enriched by restaurants, cafes, and pubs. Most of the families stated that a roof garden is a safe place for their children to play and run around. Some of the participants (n=12) also mentioned that they would like to see more vibrant activities in the roof garden. The author’s photographs (see Fig. 5) show an example of a display of colourful artwork, as a way of varying the user experience, compared with their experiences from previous visits.

3.2.7. Suggested activities and design features

When describing what they would change to improve the roof garden design, the most frequently mentioned comments were: more comfortable and movable seating spaces; a sheltered area to protect from rain; a water fountain; varied widths of pathways; and more flowers and plants. Others mentioned such features as an outdoor café, kids playing area, pet-friendly zone, interactive night lighting, and an outdoor viewing platform to see Canary Wharf. Most of the participants (36 respondents; 81% of those interviewed) stated that a water feature and a covered roof area to protect visitors from rain during the winter was highly needed to improve the design. A significant percentage of the older adult participants (8 respondents; 18% of the interview sample), however, stated that they are satisfied with the current design of the roof garden and they don’t think the roof garden needs other activities or new design elements.

Participants had mixed responses when asked about what would encourage them to interact with others or what they would change to help facilitate social interaction. The most commonly mentioned responses included organised events such as a magical installation inspired by the Jardin Majorelle in Marrakech, and live music events at the amphitheatre, either for free listening (licensed buskers), or for an advertised event with tickets. Many participants also stated that some of the seating benches should be replaced with interactive social seating areas. Some participants also spoke about educational and interactive features such as banners describing the plants, statues, public art on the roof garden walls, a piano, games tables, and a Koi pond. There was a public piano, pre-covid, which the frequent visitors remembered, however, this was removed because of the labour of sanitizing it after each use and it has not been replaced despite their no longer being a requirement for sanitisation.

The most frequently mentioned features regarding what would encourage participants to be active in the roof garden included more plants and flowers, fitness equipment, yoga classes, table tennis tables, interactive night lighting pathways, and different themes and events. Walking was the most dominant activity by all the age groups and many participants stated that they feel safe

allowing their children to run and play freely in Crossrail Place area. Features that participants (26 respondents; 59% of the interview sample) suggested being added to the roof garden were sporting equipment, wider walking pathways, organised events and a kid's playing area.

"...some tables and chairs where you could actually sit with someone opposite them, more social spaces as it doesn't feel super-social. Some spaces where you can actually sit with more people instead of just benches that make you feel more isolated" (Female, aged 26, living in Canary Wharf).

"...maybe more things you can interact with like reading spaces. Like you see this statue over there ... you can read about it. ...more things like that will be pretty cool" (Female, aged 25, living in London).

"They can do more educational and interactive stuff. There were a few banners describing what plants are here and the different species...it's free space so obviously they would not put too much money into something for which no one paying to get in ... they could do a few more educational things" (Male, aged 29, living in Canary Wharf).

"If they have a fishing pond that would be quite lovely, it goes with the overall design and environment" (Female, aged 27, living in London).

"Sports may be like a calisthenics park. I would like to exercise here" (Male, aged 31, living in Canary Wharf).

4. Discussion

This research study has highlighted the outcomes of the observation results and the semi-structured interviews conducted at Crossrail Place before, during, and after the COVID pandemic and a summary of the core findings is presented below.

This study has identified an increase in both the number of people visiting Crossrail Place during the pandemic and the average time visitors spent there. This increase in the number of youths, children, and families visiting the roof garden reveals the sense of safety and security in the place. Overall, a majority of the participants (90%) found the roof garden to be a safe place to visit during the COVID-19 pandemic due to the roof ventilation and the high-security. The study also highlighted the presence of new activities taking place in the roof garden during the pandemic such as reading (short story stations), relaxing, playing, and family picnics. A significant percentage of the participants (41%) reported that visiting the roof garden on regular basis during the pandemic to sit, relax, and chat with friends had a positive impact on their mental well-being.

The results of this study align with previous studies which discussed the design problems and principles that need to be considered when designing vertical urban spaces (Oldfield, 2019; Cho et al., 2015; Pomeroy, J., 2013). In the Crossrail Place case study, many design aspects need to be improved in accessibility, circulation, design, and management. These include improvements to the visual accessibility to the roof garden from the street level, and widening the narrow pathways that cause a feeling of a lack of privacy. There is also an essential need for a sheltered

canopy to protect the people from the rain in the open sections, a need for public toilets on the roof garden floor, an outdoor viewing platform, and comfortable and movable seating chairs instead of fixed wooden benches.

Nine key qualities that the study participants most frequently refer to when describing their ideal roof garden were: accessibility; provision of activities, comfort; sociability; quality of management; publicness; security; green natural planting; and natural ventilation. Other principles that must be considered when designing an accessible roof garden include: a variety of transportation options in the wider urban context; a direct connection between the roof garden and the street-level surroundings; and a semiotic indication, signalling that there is a pleasing roof garden interior to be found if visitors come into the building (e.g. green tree foliage in a sky garden visible to a person walking at street level near the building communicates more effectively than signs) (Viñoly et al., 2015; Yeang, 2002; Samant, 2019). The roof garden, once discovered, must also function for people with special needs. In short, visitors must have easy access and feel that they can walk comfortably in the roof garden.

Seating organization is one method to facilitate social activity in vertical green spaces and a variety of seating types is therefore advisable. The main challenge with seating fixtures in roof gardens is not the lack of provision, but instead, the arrangement and positioning of seating, grouping, design, the level of flexibility, and availability of weather protection. Key aspects of quality seating in roof gardens therefore include flexibility and adjustability, together with comfort, and arrangement (Cho et al., 2015; Nordh & Østby, 2013). Indeed, movable chairs and benches with different orientations can improve the variety and choice of seating, for comfort and user experience. When implemented well, good seating improves social interaction and passive activities, such as people watching others. Interactive objects of interest such as fountains, plants, installations, game facilities, interactive displays, pianos, swings, and public art sculptures are also highly recommended to activate a public roof garden. These elements bring a unique character to the roof garden while also serving as an attraction that encourages visitors to stay longer, or return later with friends (Rivera et al, 2021).

Vertical urban space management in vertical roof garden spaces should encourage inclusion through light-touch regulations, rather than the hard exclusion of undesirable behaviours through restrictions on people, activities, and animals unless their risk assessment is aware of realistic nuisances and threats (Hadi et al., 2018; Samant & Hsi-En, 2017; Oldfield, 2019). Indeed, there is a need for creative thought to actions and considerations that activate life in the vertical public realm rather than prohibit them. New guidelines should therefore limit the number of restrictions to essential and reasonable ones, employ plans for user participation in the roof garden management, and regulate spatial uses and actions, rather than just prohibiting them. These actions can be regulated by offering safe spaces for animals and smokers and those playing with balls and skateboarding.

It is also opportune for designers to consider the potential of new technologies to better engage the public in the design process. Indeed, previous research suggests that the principles of intelligent design for these vertical social spaces should be used with the flexibility derived from

a deeper understanding of justifications and interrelations. Computer modelling technology such as 'Virtual Reality' (VR) can help as a method to form a new experience of 'Extended Reality' (XR) thereby acting as a design tool that engages human users as active participants in the design process (Stals & Caldas., 2022; Van Leeuwen et al., 2018). The use of XR in the design of vertical social spaces can enable a strategic intervention approach that identifies specific opportunities, selecting a set of improvements, avoiding mistakes, and prioritising the design actions that enhance the quality of the vertical urban space. These new design actions could be tested and changed by the users in their real-time in their 'virtual world' and therefore inform design decisions. This can all be done before the 'real world' physical roof garden or refurbished roof space has been built and therefore improve on the design outcome and future user experience.

5. Conclusions

This study has provided evidence that during the COVID-19 pandemic the number of visitors to Crossrail Place roof garden increased. Significantly, 79% of the study participants (n=35) declared that London needs more open and well-ventilated roof gardens that should be part of the city's future development plan. This chapter gives an overview of the future design principles and limitations for the design of vertical green spaces in the post-pandemic era. Most of the interviews were conducted by strolling through the garden with the interviewees, a method which helped in analysing context-specific information by observing their behaviour and reactions, and not merely hearing their words. This enabled the researcher to identify how social and physical factors interact to expose the characteristics that influence the use of Crossrail Place.

This research study on the current design and management of Crossrail Place has identified critical issues regarding the design of vertical roof garden spaces as well as how these can change during pandemic situation. These include factors such as accessibility, circulation, activities, suggested design features, limitations of visitors, and social distancing. The study's results have important implications for the future design and need for vertical social spaces and roof gardens in London. It must always be said that further investigation is needed and that this has been amongst the first studies that explore how people are using vertical green social spaces before, during, and after the Covid19 pandemic. There will be more requirements and opportunities for the study of vertical social spaces as their implementation as new public spaces in cities spreads, especially if other cities are inspired by outstanding exemplars such as Singapore.

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