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Green spaces in housing development – buyers’ preferences

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Abstract. Globally, extreme weather events are occurring more often, with increased intensity due to anthropogenic climate change. For example, in July 2022, monthly average temperature in Spain was 2.7 C above average, and UK has recorded temperatures above 40 degrees for the first time. It has been proven that implementation of green spaces in cities helps to address environmental, social, and even economic problems by providing ecological services, reducing temperature, and attenuating the heat island effect, providing aesthetic enjoyment, recreational opportunities and decreased stress levels. However, green infrastructure is rarely prioritised by developers. It has been argued that, due to space constraints, green infrastructures are an inefficient land use, costly to maintain, and that there is uncertainty if green infrastructures are valued by the market. This paper reports on results from a study examining the attractiveness and the effect of green spaces on housing market customer’ perceptions. To analyse the impact of green spaces, we worked with landscape architects and residential housing developers designing a multi apartment building with a courtyard. The courtyard area was designed accordance to The Green Area Factor resulting in five courtyard designs, each with a different level of greenery. All five designs were presented in dynamic virtual views and embedded in a survey questionnaire. Maintenance costs of all five green spaces were calculated. The findings shows that greenery does effect the perceived attractiveness of residential development. Maintenance costs for the courtyards, with lowest and highest level of greenery, differ by approximately 10 percent of the total maintenance costs. These findings are applicable in the context of new housing construction and renovation projects.

1. Introduction

Anthropogenic climate change is warming the planet, and extreme weather events globally are occurring more frequently, with increased intensity. For example, in July 2022, Spanish monthly average temperature was 2.7 C above average and the UK recorded temperatures above 40 degrees for the first time. In urban and developed areas, temperature is exacerbated with hard surfaces reflecting and radiating more heat and is known as the urban heat island (UHI) effect.

Population and economic growth increases demand for housing and infrastructure, such as roads, public spaces, drinking water, and sanitation. Urban expansion through city development has led to considerable changes in land cover, introducing high-rise buildings, shopping centres, car parks and residential developments whilst decimating natural habitats, and a failure to protect green infrastructure and biodiversity [1].



Green and blue infrastructure (GI) contributes positively to improved atmospheric conditions through better air quality, attenuation of the urban heat island, creation of social amenity space, a habitat for biodiversity, and stormwater attenuation [2,3]. Research shows that ecosystem services are a prime factor contributing to human well-being [4–6]. Krekel et al. [6] show that access to green urban areas, such as gardens and parks, is positively associated with satisfaction, whereas access to abandoned areas, such as waste or leftover land, is negatively associated with life satisfaction. Green spaces increase participation in outdoor activities, decrease stress and anxiety levels providing a buffer against negative health impacts [7–9]. However, green infrastructure is rarely prioritised by residential property developers. Previously, it has been argued that due to space constraints green structure is an inefficient land use, costly to maintain, and there is uncertainty if green structures are valued by buyers and sellers in the market.

This paper explores these perspectives and reports on the results from study examining the attractiveness and the effects of green spaces on housing market customers perceptions, undertaken during 2022. The premiss is that high levels of GI increases the attractiveness of building development and affects buyer's interest, and that possibly buyers may be willing to pay a higher price, and thus cover the costs related to increasing GI within property development.

2. Green space in housing development

A criterion for sustainable cities and property is having good green space [3]. Urban green space incorporates the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provides various benefits to people and wildlife [1]. Green space solutions can be applied on various scales, from the broader landscape scale to the home or building level. At the local scale, green space includes rain gardens, green roofs, infiltration planters, trees and tree boxes, and permeable pavements [10–12]. Forests and national parks are important green spaces on a regional level [13,14]

Green spaces, green roofs and walls, trees, and grassed areas can enhance resilience and offer significant benefits economically, socially, and environmentally [15]. Green spaces were found to absorb more intense rainfall, helping with stormwater management protecting from floods [16]. In dense urban areas green roofs, facades, and walls contribute to these benefits, providing better air quality, space for social interaction and relaxation, helping to manage urban stormwater, reducing the UHI effect, and improving urban biodiversity [12].

While there is a growing awareness of the value and importance of green space, there is little consensus on how green space can be valued [15,17–19]. Green spaces and related ecosystem services are underestimated in decision-making, as their full values are not fully apparent [20]. The values derived from green spaces can be qualitative, and or quantitative, or economic, in nature. The most common approaches include cost–benefit analysis (CBA) [21], life cycle costing (LCC), triple bottom line [22], and various combinations of life cycle assessment (LCA). Some researchers argue these models are incomplete in some respects and question the reliable evaluation of trade-offs between economic and environmental performance [23,24]. Moreover, comparison of costs and benefits on local, regional, national, and even global levels, are very complex, since the value created is shared by different stakeholders, including tenants and the local community, the local and regional economy [25]. However, in case of property investment, development, and ownership, the business case for specific green space investments is not always clear, therefore different policy instruments, incentives, and even compensations have been proposed.

Property developers and real estate owners tend to have special interest in how green space is valued by the customer, therefore considerable research has focused on consumer buying processes (e.g. [26,27]) and buyers' willingness to pay (WTP), which could be related to green products, services, or the green aspects [12,28–30]. Rademaker et al's [31] research showed consumers perceptions and evaluations of the brands or products are affected by green aspects used for marketing products or brands. Consequently, green aspects such as green space in case of residential property may appear important too.

Buyers' present and future needs and preferences are fundamental in purchase evaluation and psychological cost-benefit analysis, therefore priority and significance that green space have for individual and positioning among those needs will play role in output of customer evaluation [32].

Daamas and Siljtsma [33] found that inner city, densely developed residential areas attribute high value to green spaces, whereas less densely developed areas, such as suburban areas, values of green space were lower. In more densely developed areas, consumers tend to pay a higher price for green space, and moreover these green space areas are generally smaller in size.

The proximity and reason to use green spaces affects how important green spaces are for customers. For example, the closer a green space is to home, the more likely it is used [5]. According to Danish research [34] people who live within 300m of green space, visit green space on regular bases, at least once a week, only less than one percent never visit green space. The study indicates that enjoying the weather and getting fresh air are the most important reasons for visiting green spaces, however, the intention to use green spaces can be affected by quality and characteristics of green areas [13,35].

The latest experiences with COVID pandemic and, in many places, long lasting lock-downs and restrictions have revealed need for outdoor space and green areas [36]. The study shows that willingness to pay for green roofs and possibility to access green roofs a good option to enjoy greenery close to their homes.

Studies showed that tree shading can block out light in houses or apartments [11] which may be welcome at some times of the year and not at other times. Trees canopy can be perceived as aesthetically pleasing and valued environmentally as they lessen pollution; however, untrimmed trees and large bush areas may affect people's sense of safety [37]. Proximity to parks may have negative effect on prices, especially if it is considered unsafe and crime related places [38].

An important consideration is the impact of GI on the maintenance and facilities management for these medium density housing developments. Liberesso et al., (2020) [39] noted the additional maintenance costs associated with the installation of green infrastructure. The level and frequency of maintenance is affected by the design and also quality of the materials specified [40]. For example, some plants need more watering and pruning compared to other species. GI can also be adversely affected by extreme unpredictable weather events such as flooding or heatwaves which may create unexpected maintenance costs. Some designs are more labour intensive to maintain and innovation in robot technologies may offer a means of reducing labour costs associated with GI maintenance [41]. Finally many FM professionals have expertise in construction more so than soft landscaping and green infrastructure, and this may impact on optimising maintenance costs and the health of the GI. The FM's awareness of the impact of GI on biodiversity, other environmental benefits and capital value may also be lacking.

3. Method and data collection

The attractiveness and the effect of green spaces on housing market customers perceptions was tested through an experiment embedded in a survey. 450 responses to a survey questionnaire, distributed in May 2022 in Sweden were received. Responses were collected through Nordstad, a panel platform.

3.1. The survey-based experiment

All respondents, who were interested to purchase an apartment in the next 2-5 years, were asked to respond to the following survey questions. The survey questionnaire comprised 31 questions. First questions asked respondents about the importance of different aspects of an apartment they would buy including; size, design and specific characteristics, location, characteristics of its nearby area. In the second stage, respondents were exposed to an experimental stimulus, where they viewed an apartment with all the characteristics the respondent considered to be very important or 'a must' in their purchase. Subsequently, respondents were asked to view the apartment building and its courtyard in a dynamic virtual reality.

This design survey-based experiment ensured that respondents were interested in the apartment and the building because the residential building complex they were to view, already fulfils most of the

needs and requirements respondents had specified earlier. The only factor that was unspecified in full was the courtyard and its level of greenness. The level of greenery has been randomly assigned in survey. After respondents have viewed the courtyard, a number of questions asked about the attractiveness of the building and its courtyard and their interest in purchasing and owning an apartment in the viewed building. Finally, respondents answered questions about demographic and socio-economic factors.

3.2. Courtyard design and greenery level

Five green courtyards were designed in cooperation with landscape architects. Designs were based on existing a residential housing development. The courtyard area was redesigned accordance to The Green Area Factor (GAF), which is an index weighting surface types and their attributes, for example soil functioning, naturalness of the vegetation, and green amenities for people. The GAF is used to design and to promote nature-based solutions in urban development at the property level. In Sweden, the GAF, called GYF was developed and first applied in 2001 in Malmö [42]. The GYF applies multifunctionality approach to take consideration and to incorporate different technical expertise: biology/ecology, building architecture and construction engineering, civil engineering, fire safety. Landscape architects use the GYF tool to assess green space area and quality within property boundaries. The higher GYF factor, the greater ecological contribution and value of ecosystem services [42].

Five courtyards, each with a different level of greenery, were presented in dynamic virtual views and embedded in a survey questionnaire. Presenting courtyards design in a dynamic view allowed the respondents to explore courtyard in three dimensions and from two different positions. The space actively can be actively experienced from 360 degrees and the viewer can change and adjust the angle of own view.

Greenery was included in all courtyards, therefore all provide biodiversity, climate resilience, social and sound qualities, however, the contributions quota (quality) varies (Table 1). According to GYF calculations, the courtyard with level 1 contributes to climate resilience in 15% whereas contributions of level 5 are appraised to 45%.

Table 1. Courtyard environmental contributions [%].

| | Courtyard green level 1 | Courtyard green level 2 | Courtyard green level 3 | Courtyard green level 4 | Courtyard green level 5 |
|---------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Biodiversity | 21% | 26% | 35% | 44% | 53% |
| Social qualities | 17% | 21% | 24% | 31% | 45% |
| Climate resilience | 15% | 15% | 20% | 30% | 45% |
| Sound quality | 20% | 20% | 40% | 60% | 60% |

Figure 1-5 present five different levels of courtyard, pictures are presenting courtyard from one position.



Figure 1. The courtyard with the lowest level of greenery, level 1, green area factor 0.81.



Figure 2. The courtyard with the second level (2) of greenery, green area factor 0.86.



Figure 3. The courtyard with the third level (3) of greenery, green area factor 1.16.



Figure 4. The courtyard with the fourth level (4) of greenery, green area factor 1.36.



Figure 5. The courtyard with the highest level (5) of greenery, green area factor 1.47.

3.3. Construction and maintenance costs

Estimated construction costs for the courtyard and increasing greenery were calculated based on Swedish prices available as of November 2022. The cost estimates included prices for materials, workers and machines, overheads (assumed as 20%) and contractor's fee (assumed 10%). The calculation assumes that the land to be built on is level and consists of existing soil. All surfaces are excavated by 0.5 m before construction. The cost of foundation reinforcement or demolition on top of existing soil is not included. The calculation excludes developer costs such as landscape design, project and construction management and client administration. The total area of the courtyard is 4171 sqm.

The maintenance and operation cost calculation contain recurring work steps for operation of both greenery and hard surfaces. The maintenance and operation cost refers to established greenery that is in good condition coverage of the surfaces. This assumption arrives from the fact that, in the first years after installation, establishment maintenance is needed and this is more extensive than the subsequent maintenance care as the surfaces have not had time to adjust.

Both perennials and bushes areas do not cover the ground, meaning that additional weeding is needed. It is assumed that trees may need more extensive pruning and climbing plants need to be tied up (affecting cost for courtyards with greenery level 4 and 5).

The cost estimates included materials, labour and machine costs required for the work and other overheads. The hourly rate for one garden worker is set at 45 euro/hour. The calculation is based on prices available as per November 2022 and assume normal usage of greenery space.

4. Findings

4.1. Attractivity of the courtyards - customers perception

Respondents presented clear preference towards location of the apartment they want as majority (81%) would like to live in the centre or, just at the limits of the city centre. Five most important factors in regarding to location in decreasing order were: parking space, easy access to public transport and accessibility to general services and facilities as shops, nature and parks located in the neighbourhood. The results indicate that even though the majority of respondents would prefer to live in city centres they also have high preference towards green areas.

Different levels of 'greenness' of the courtyard of an apartment building and influence the interest in and attractiveness of the apartment complex was tested. Results show that approximately 80 percent of respondents do not believe that courtyard has too much greenery. Nearly 40 percent felt that courtyards had fairly light levels of greenery. Those perceptions did not differ significantly depending on which courtyard respondents were exposed to. Respondents showed high interest in purchasing apartments in the development presented, and the interest increased with the level of greenery of the courtyard (Table 2).

Table 2. Courtyard greenness and buyers' interest [%].

| | Courtyard green level 1 | Courtyard green level 2 | Courtyard green level 3 | Courtyard green level 4 | Courtyard green level 5 |
|-----------------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| No or very little interest | 21,50 | 17,30 | 16,70 | 11,80 | 0 |
| Fair interest | 51,90 | 52,00 | 55,10 | 41,20 | 50,00 |
| High interest | 26,60 | 30,70 | 28,20 | 47,10 | 50,00 |

Difference groups has been tested with the Chi-Square test and results indicate that interest for courtyards with increasing green levels differ, at the significant level (<0.01). The majority of respondents found courtyards fairly attractive. The attractiveness of the courtyard increases with the courtyard greenery level (Table 3).

Table 3. Courtyard greenness and attractiveness [%].

| | Courtyard green level 1 | Courtyard green level 2 | Courtyard green level 3 | Courtyard green level 4 | Courtyard green level 5 |
|-------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Not attractive | 10,1 | 5,3 | 7,7 | 7,1 | 0 |
| Fairy attractive | 65,8 | 68,0 | 62,8 | 55,3 | 51,3 |
| Very attractive | 24,1 | 26,7 | 29,5 | 37,6 | 48,8 |

In general, respondents found the courtyards to have enough of social spaces. Approximately 11 percent of respondents found the courtyard with level 1 greenery, had too few social spaces. Difference in perception of social spaces for different courtyards was not at the significant level.

4.2. Construction costs

Estimated costs for establishment of the courtyards was calculated based on 2022, November prices. The courtyard preparation and works including fixed infrastructure (stairs, pavement, and walking areas), ground works and social spaces and features (lamps, playground) are the same for all courtyards levels. The only difference in estimation are posts related to plans and planting. Those are increasing

from 152 404 euro for level one to 541 821 euro for preparation, plants and planting in level 5 (Table 4).

Table 4. Planting related costs per level, comparison to base= level 1[Euro].

| | Courtyard green level 1 | Courtyard green level 2 | Courtyard green level 3 | Courtyard green level 4 | Courtyard green level 5 |
|---|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Total cost | 730 730 | 754 951 | 774 311 | 1 002 402 | 1 120 144 |
| Greening costs (including vegetation, planting and green roof) | 152 404 | 176 625 | 195 985 | 424 076 | 541 821 |
| Difference | Base | 24 221 | 43 581 | 271 672 | 389 417 |

The greatest difference between levels is implementation of green roof in courtyards level 4 and 5. Green roof in courtyard level 4 has a depth of 50-110mm, with area of 1291 sqm; and costs 185 904 euro. In courtyard level 5, we upgraded the green roof quality to plant based green roof with a thickness of 110-300mm; and an estimated cost of 277 565 euro. Introduction of green roof in courtyards level 4 and level 5 increased the green area in the building development significantly, adding an additional 1291 sqm and therefore increasing the ecological value significantly.

Trees are a very important part of landscape, therefore we increased number and maturity of trees with each level. Younger and smaller trees are planted in courtyards level 1-3, whereas in courtyards level 4 and level 5 included more mature trees. Costs for planting trees in level 1 are estimated to be 17 600 euro, in level 3 they are 42 750 euro, and the costs for level 4 and 5 is approximately 91 600 euro. Costs for planting more mature trees are higher due tree prices but also due to works and material related to ground preparation.

If we assume that a building development includes 30 apartments, and if the cost of increased greenery is divided equally, then to cover extra costs, in case of development with level 4 of greenery, the price per apartment could increase by approximately 10 000 euro.

4.3. Maintenance and operation costs

Maintenance and operation costs for courtyards include the mowing of lawns, trimming of bushes and trees, removing weeds and flower plants care, cleaning pavements and walking areas, cleaning playground and social spaces, clearing wells and stormwater areas.

Types of areas in courtyards changes and that affects maintenance and operation activities and consequently costs. The courtyard level 1 includes walking areas of 1230 sqm, playground space of 230 sqm, lawn of 670 sqm and 609 sqm area for vegetation, bushes and perennials. Walking and social areas are not changed, however, the lawn area is lowered and replaced by trees, plants, perennials, meadow and in courtyard level 5 by a pond. The courtyard level 5 includes 200 sqm of lawn, 507 sqm area for bushes, 360 sqm of area dedicated to perennials, 135 sqm of meadow and, 37 sqm of pond.

Table 5. Maintenance and operation costs per level, comparison to base level 1[Euro].

| | Courtyard green level 1 | Courtyard green level 2 | Courtyard green level 3 | Courtyard green level 4 | Courtyard green level 5 |
|----------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Total M&O costs | 21 196 | 21 766 | 22 576 | 22 968 | 24 018 |
| Difference | base | 570 | 1 380 | 1 772 | 2 822 |

One of the main costs in courtyard maintenance, except for general cleaning and supervision, is weed clearing (85 hours per year). This is followed by lawn mowing (approx. 48 hours per year). Lawn maintenance requires purchase or leasing of a mower, which is additional yearly cost. As lawn area decreases, costs related to mowing decreasing as well.

The increase in costs for maintenance and operation of courtyards relates mainly to removing weeds and trees trimming activities, however, there is a significant cost reduction due to the decreasing lawn area. The differences in maintenance and operation between level 1 and level 5 is approximately 10 % of the total annual costs, summing up to 2822 euro per year (Table 5).

5. Conclusions

It is predicted that by the 2050, nearly sixty percent of the global population will live in cities. In order to increase resilience of cities and to minimize urbanization contribution to the climate change, new ways of urban planning and design need to include increased green spaces. The accelerating rate of green space investment is indicative of the value created for the diverse range of stakeholders.

This study shows that attractiveness of green spaces in residential building complexes increase with the level of greenery. The interest to purchase a dwelling increased with the level of greenery in the courtyard. Considering that interest and attractiveness matter significantly in the buyer's psychological cost-benefit analysis, it can be concluded that green spaces may influence willingness to pay price for a dwelling [32]. If the greenness of the courtyard increases attractiveness and interest of a buyer, the apartment attracts a greater number of potential buyers (bidders). Consequently, in situations of bidding, the urgency of the situation and the perceived competition (ie. number of potential buyers, see Thaler [43]), it is possible that WTP for the apartment increases and thus a higher the price is paid which may cover the costs of the greenery.

The study presents costs difference for constructing the courtyards with different level of greenery. It found that green roof contributes significantly to production costs, but also increases general quality of the green space and contribution to climate resistance and biodiversity.

The results are applicable and relevant for new construction, but also for renovation of older apartment buildings. Renovation of common outdoor spaces and incorporation of higher level of vegetation could increase attractiveness of the building and increase property values.

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