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Willingness to Pay for Green Infrastructure in Residential Development—A Consumer Perspective

Agnieszka Zalejska-Jonsson [1,*], Sara J. Wilkinson [2] and Richard Wahlund [3]

1 Department for Real Estate and Construction Management, KTH Royal Institute of Technology, SE-100-44 Stockholm, Sweden
2 School of Built Environment, The University of Technology Sydney, Ultimo NSW 2007, Australia; Sara.Wilkinson@uts.edu.au
3 Department of Marketing and Strategy, Stockholm School of Economics, SE-113 83 Stockholm, Sweden; Richard.wahlund@hhs.se
* Correspondence: agnes.jonsson@abe.kth.se

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Abstract: This paper investigates the literature and theoretical underpinning of the concept of "willingness to pay" (WTP) for green infrastructure (GI) with consequences for residential development. The benefits of GI in urban settlements include improved air quality, attenuation of the urban heat island, thermal insulation and lower energy bills for green roofs and walls, the creation of social amenity space, a habitat for biodiversity, and stormwater water attenuation. Collectively, these benefits are termed eco-system services and enhance sustainability. The role of GI, the "lungs of the planet", is heavily correlated to atmospheric conditions; high levels of GI improve air quality, which is acknowledged widely with many cities increasing GI to make them more resilient to future predicted challenges with respect to heat and poor air quality. In addition, there is evidence that the biophilia effect enhances human well-being. There are some studies claiming that purchasers pay a premium for property with good GI. However, there is little research about the process in consumers' minds leading to such a premium—if, how, when (under what circumstances), and then to what extent are consumers willing to pay for GI. This process, if better understood, may enable sellers or policy makers to influence the amounts of GI in developments, thus making it possible to enhance the value of GI to buyers. There is some research pointing to factors to be considered when modeling such processes. For developers, knowing the optimum amount of GI would enable them to design and construct developments with maximum purchaser appeal. To do this, stakeholders need to predict the level of WTP amongst potential purchasers for which they need to understand the decision processes behind WTP. In this way, sustainability in residential property development could be optimized. The paper analyzes the literature and theories concerning WTP, focusing on dwellings and GI. Our findings are that some quantitative evidence exists that purchasers pay more for residential property with high levels of GI in some cities, but they do so without any understanding of the possible decision processes leading to those premiums (if, how, when, and then to what extent). The paper proposes a comprehensive conceptual model that may explain buyers' WTP for a dwelling based on a presumed cost–benefit analysis performed by buyers, which has been extended here to include GI and psychological factors. Thus, the paper has a consumer perspective. The model may be used to select variables and test them in empirical studies, and by integrating with other factors in the model, it can attain a more comprehensive understanding of WTP for GI in residential development.

Keywords: willingness to pay; ecosystem services; green infrastructure; residential development

1. Introduction

The 17 United Nations (UN) Sustainable Development Goals represent the blueprint for a more sustainable future for humankind [1]. The 17 goals address global challenges faced and include, for example: eradicating poverty and reducing inequality, addressing climate change and environmental degradation, improving access to clean water and sanitation, and building sustainable cities [1]. The 17 goals interconnect, and targets are established for completion by 2030. The built environment contributes an estimated 40% of global greenhouse gas emissions (GHG) and has great potential, with changes to means of production and consumption, to mitigate the impacts of climate change and to deliver sustainable cities [1].

Environmental challenges have become a key issue in political debates globally, particularly in 2019 as groups such as Extinction Rebellion or individuals such as Greta Thunberg gain recognition of their aim to raise the lack of action taken to date at the 2019 UN Climate Action Summit in New York [2,3]. Effective action is correlated to enhancing people's living standards, and it is increasingly important to all business sectors, including residential property. Sustainable cities and sustainable property promote healthy outcomes as well as reduce resource consumption and GHG emissions. There is always a tension between those who posit that a market lead approach will deliver greater sustainability, and those who advocate for mandatory measures to ensure that minimum standards are met. Mostly, the solution is a combination of measures that are both voluntary and mandatory; however, deciding on the extent of measures is challenging.

One criterion for sustainable cities and property is having good green infrastructure [4]. Green infrastructure (GI) is defined as "incorporating both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife" [5]. GI solutions are applied on various scales, from the home or building level, to the broader landscape scale. At the local scale, GI includes rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems. Studies in Manchester UK and Portland USA [6–8] focused on green streets, trees, and grass [9,10]; a Texas study explored the effect of green paths; and Derkzen et al. [7] focused on green roofs and green walls. Other studies examined lakes and rivers [10–12], and city parks [7,11–15]. Overall positive outcomes are reported in respect of atmospheric conditions and increased amounts of GI [2,4,5].

Other research focused on the social functions of GI, investigating children's playgrounds [7], sport fields and golf courses [11,12], and churchyards and cemeteries [11,12]. At the largest scale, the preservation and restoration of natural landscapes such as forests, floodplains, and wetlands [12,16] and agriculture fields and/or abandoned fields [12,15] are also types of GI.

The literature review in Section 2 of this paper defines GI and the benefits and challenges of integrating GI into urban settlements. GI includes green roofs and green walls, trees, and grassed areas, and it offers significant, wide-ranging benefits across economic, social, and environmental aspects. As part of GI, green roofs, facades, and walls contribute to these benefits, particularly in dense urban areas. Green roofs improve air quality, provide space for social interaction and relaxation, help manage urban stormwater, reduce the urban heat island effect, provide space for urban food production, and improve urban biodiversity [17]. This range of economic, social, and environmental benefits has led to the increased uptake of green roofs, facades, and green walls globally.

The accelerating rate of investment into GI is indicative of the value created for the diverse range of stakeholders who benefit. A key challenge to a more widespread adoption of green walls and roofs is the clarity of the business case for specific investments, which are open to a wide variety of design choices that affect the cost and benefits, and which may satisfy consumers' needs or wants to different extents [18].

A challenge in quantifying the value from GI is the variety of approaches to evaluate net value. The most common approaches include cost–benefit analysis (CBA) [19,20], triple bottom line [21], and various combinations of life cycle assessment (LCA) and life cycle costing (LCC). Wilkinson et al. [18] argued while these models enable an analysis of the costs and benefits, they all are incomplete

in some dimension, and they are criticized for not allowing for a reliable evaluation of trade-offs between economic and environmental performance [18,22,23]. Economist David Pearce [22] argued conventional financial CBA was insufficient for analysis of investments, because environmental costs and benefits are excluded in the modeling.

In the case of GI, this challenge is particularly salient as substantial direct costs are incurred by property owners and investors [24–26], whereas the value created is shared by different stakeholders including tenants and the local community, including the local economy. In recognition of the shared value, a range of subsidies have been implemented to compensate investors. While recent attempts to evaluate the business case for GI have included identifying and quantifying the value created with respect to economic, environment, and community/social values (e.g., [26]), a more compressive approach incorporating a more comprehensive set of value drivers is necessary.

Whilst the literature analyzing the relationship between GI and property value to date is limited [27], there is considerable literature on consumer buying processes (e.g., [28–31] and specifically about consumers' willingness to pay (WTP), which could be related to green products, services, or the green aspects of such (e.g., [32,33]). Rademaker et al. [34] showed that green aspects of the media used for marketing products or brands influences consumers perceptions and evaluations of the products or the brand. Therefore, green aspects of products and services matter, and as noted above, GI aspects of dwellings also seem to matter.

What is lacking is a comprehensive conceptual model capturing all the main factors that may influence the decision processes behind WTP for dwellings, including GI, and that result in market values. The purpose of this paper is to propose such a model, considering the total decision process and purchase circumstances, i.e., including other factors influencing the willingness to pay for a dwelling, in addition to obvious and traditional ones concerning the dwelling itself and elucidating different types of explanatory variables.

In this paper, we discuss potential factors that a buyer may consider in an evaluation process concerning housing, including GI, or GI as such, to arrive at a willing-to-pay price. In the reasoning posited, we outline the main factors assumed to affect WTP and refer to attributes and factors influencing the evaluation process. This is an initial study aiming to develop a conceptual model to guide further studies of WTP for housing and GI. As such, we are aware that the list of factors assumed to affect WTP for housing and GI may not be complete and may change over time.

2. Development of an Extended Cost–Benefit Analysis Model of Willingness to Pay for a Dwelling and Its Green Infrastructure

When buying or renting a dwelling, the consumer must make a decision about what to pay for it. Assumed to be basic driving forces behind the willingness to pay are the perceived costs and benefits of owning or renting a dwelling, or of GI investments per se, related to one's needs or wants concerning the dwelling or GI and what one can afford due to restrictions (e.g., [28–31]). GI may contribute to both costs and benefits. Our definition of WTP for a dwelling is the final outcome of a cost and benefit analysis (CBA) by the consumer concerning a dwelling offered in a residential market, where costs have a negative and benefits have a positive influence on WTP.

Since house buying is generally an infrequent and important buying decision for consumers, the buyer is usually in a high involvement state [35]. The buying process is generally characterized by extended problem solving [36,37] and thus an extensive CBA. We extend the CBA with two factors assumed to influence the evaluation process, or the WTP, directly. First, we add psychological and socio-psychological factors related to the buying or decision situation are assumed to have a direct influence on the final decision about the price one is willing to pay. Second, we add factors concerning how consumers perform the CBA when weighing different costs and benefits against each other, including evaluation rules and other mental aspects.

The model specifies demographic, socio-economic, and other buyer-related factors as proxies for needs or wants, which directly influence the evaluations of costs and benefits of the housing or GI

offers at hand, and which also function as restrictions for WTP (such as income and other financial resources). Another input to the CBA is the housing, or GI offers, at hand. The model specifies a number of different categories and is presented in Figure 1. The aim is that in applying this model to home buyers and analyzing the data, it is possible to assess the amount of sustainability in residential property development from GI that a market-led approach would deliver.

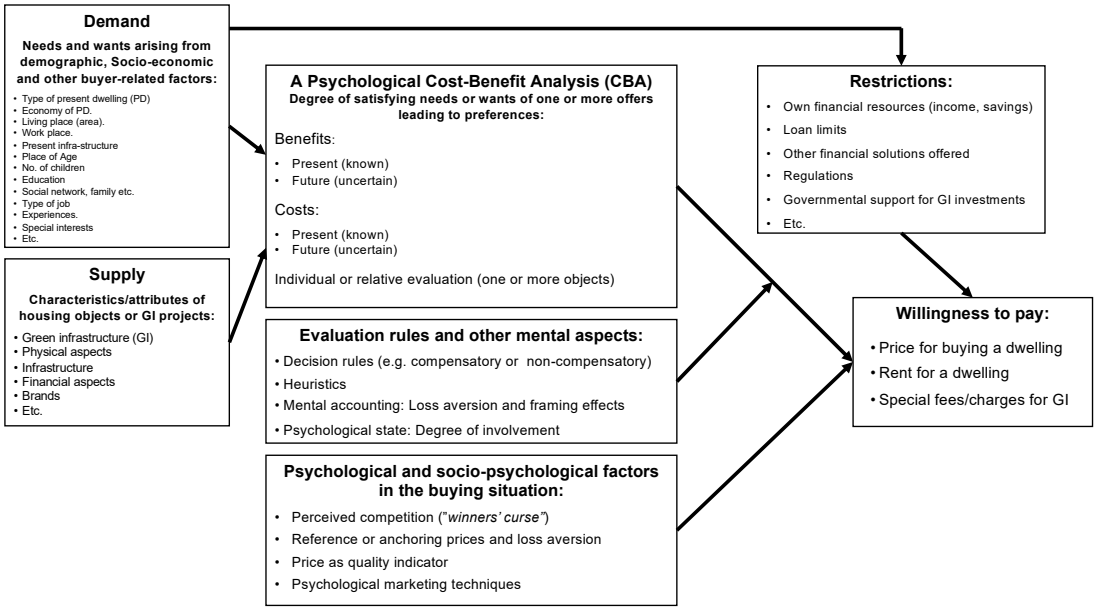

Figure 1. Willingness for Pay for Residential Property and Green Infrastructure (source: Authors).

2.1. The Dependent Variable

Since what a consumer pays for a dwelling is a cost—an expense—to the consumer (although it may also be an investment, i.e., a positive financial benefit in the future), we need to separate the price one is willing to pay to buy, or rent, a dwelling or for GI per se, from the operating costs related to owning, or renting, a dwelling that are part of the CBA and, as such, influence the WTP (in other words, separating dependent from explanatory variables). Thus, the "willingness to pay" in our model concerns:

(a) The price one is willing to pay for buying a house or an apartment (thus not the running costs of owning a dwelling, which are considered explanatory or independent variables, included in the CBA).
(b) Rent to be paid for a rented dwelling.
(c) Special fees or charges for additional GI aspects to be accepted, when one already owns, or rents, an apartment or a house.

The decision to buy or rent a house or an apartment (houses and apartments are henceforth referred to as dwellings) is influenced by variables related to the dwelling, such as location, size of the property, access to amenities and transport, employment, schools, and healthcare (i.e., infrastructure), costs of borrowing and access to lending and so on, which has been extensively studied [38,39]. There is evidence in Australia that having good GI can add economic value (i.e., people do pay additionally for GI aspects). For example, the 2017 AECOM report on Cities and Green Infrastructure [27], based on sales data, concluded that a typical Sydney house with good GI was valued at a $50,000 premium. Canadian research estimated that buildings with a recreational green roof increased property value by 11% and that buildings with views of green roofs have a 4.5% increase in property value [40]. Peck et al. [41] estimated that green walls increased Canadian property values between 6% and 15% with a midpoint of 10.5%. François et al. [42] estimated a more modest 3.9% increase in residential

property in Quebec with green walls. Green spaces were found to generate premium in Shanghai, adding 8.7% to the property price for each additional unit of the community green space ratio [14].

Czembrowski et al. [43] categorized Stockholm's urban green areas and estimated that multifunctional green spaces generate the greatest economic impact, impacting the property price by 10%. Researchers estimated that properties at a distance of 0.25 km from attractive green spaces sold at 7.1% higher prices than houses in a reference group, but these were located farther than 1.25 km away from attractive green space [44]. Research conducted in US, Portland, Oregon, correlated between tree canopy size and property price, estimating that the increase in tree canopy generated a direct effect on property sale prices of approximately 12,500 USD [8].

A UK study explored the question of willingness to pay through a 3D visualization of three alternative urban greening scenarios [45]. The results indicated that people were willing to pay up to £10.56, or 2% of monthly rent, for locations with a high-quality GI environment. Italian households were found to be willing to pay extra charges of approximately 6.5 euros for GI in the area and a premium of 16.5 euros per year for being surrounded by parkland [15]. Results from research conducted in Hong Kong suggested that households were prepared to pay an extra charge of nearly 10 USD per year to recover and maintain green space areas.

2.2. Explanatory Variables: A Psychological Cost–Benefit Analysis (CBA)

There is an extensive number of possible benefits and costs that consumers may consider in a CBA to arrive at the price they are willing to pay for a dwelling, or GI. Table 1 lists some categories, with some examples of costs and benefits for each (some of which are discussed below). Since this paper is focused on GI, aspects of GI are discussed and listed in the table first (based on [17]) followed by more traditional costs and benefits of a dwelling. In this section, some notable studies that provide an indication of the magnitude of the value created in some of the domains listed in Table 1 are presented.

As to costs and benefits, we differentiate between current, or known, costs and benefits, and possible future costs and benefits—thus, uncertain variables (not specified in Table 1). For example, the latter concern planned but not yet decided or delivered GI developments. In these cases, the degree of perceived uncertainty should be considered [46].

Table 1. Types of costs and benefits to be considered in a cost–benefit analysis (CBA).

Types of Factors in a Cost–Benefit Analysis and Examples	Examples of Perceived Benefits	Examples of Perceived Costs
Green Infrastructure		
Supply of green products and services (such as potential to rent bicycles and access to healthy natural environments)	Satisfaction from the consumption of such, or the availability of it	Space used and perceptions of messiness
Technologies (i.e., green roofs and walls) for energy saving etc.	Direct cost savings	
Technologies for improved environment for example air quality, CO_{2e} absorption, or removal of Volatile Organic Compounds (VOC); noise reductions	Increased quality of life: physical or mental health	
Stormwater management such as absorption and storage of rainwater	Cost savings by avoiding flooding	Possible additional running costs
Nature (parks, forests, water, etc.) within reach, including biodiversity (flora and fauna)	Increased quality of life: physical or mental health well-being	
Quality and aesthetics	Satisfaction and well-being	Allergies, maintenance cost

Table 1. *Cont.*

Types of Factors in a Cost–Benefit Analysis and Examples	Examples of Perceived Benefits	Examples of Perceived Costs
Physical Aspects of the Dwelling		
Size (number of rooms, etc.)	Want or need satisfaction	Dissatisfaction if too little
Floor level (apartments)	Want satisfaction	Dissatisfaction if not wanted
Level of materialistic standard	Want satisfaction	Dissatisfaction if too low
Type of building materials	Want or need satisfaction	Allergies
Infrastructure		
Distance to stores, health care, etc.	Need and want satisfaction	Need and want dissatisfaction
Distance to work, schools, etc.	Need and want satisfaction	Need and want dissatisfaction
Available local transportation	Need and want satisfaction	Need and want dissatisfaction
Financial Aspects		
Possible return on investment	A possible gain	A possible loss
Fixed monthly fees or charges		Payments to be made
Instalments and interest to be paid		Payments to be made
Operating costs		Payments to be made
Psychological or Socio-Psychological Aspects		
Distance to friends and family	Need and want satisfaction	Need and want dissatisfaction
Detachment to the area	Need and want satisfaction	Need and want dissatisfaction
Social identity from the building or the area	Need and want satisfaction	Need and want dissatisfaction
Personal or social identity from the building, other dwellers, or the area	Need and want satisfaction	Need and want dissatisfaction
Brands and other Signals	Positive Associations	Negative Associations

(Source: Authors).

2.2.1. Green Infrastructure

Supply of Green Products and Services

Anderson and West [11] and Daams and Sijtsma [47] found that dense areas (urban resident, close to CBD) give high value on green urban spaces, whereas less dense areas (suburban) value for GI was lower. In more dense areas, consumers tend to pay s higher price for GI, but these areas are generally smaller in size [47].

Considering a potential buyer who allocates a certain value for GI amenities, it is likely that an overestimation of GI value will appear in urban spaces due to relative low accessibility (supply) and the existing level of green coverage in comparison to suburban areas. On the other hand, in lower density areas, WTP is most likely underestimated, since the general GI level and saturation is relatively higher than in close CBD areas. Additionally, in low density areas, the competition for GI facilities is lower [47]. Research conducted in the Netherlands, Germany, and Denmark concluded that individuals use existing green infrastructure to create a "portfolio of places", using local and more distance green spaced to fulfill needs for nature–relationship [48]. The findings imply that the existence of GI at the local level is conditional for satisfying those needs in everyday living.

Availability and accessibility to GI can have perceived both positive and negative effects at the same time; for example, GI can offer dog resting areas, but at the same time, it may cause an increase of dog fouling [6]; trees may attract birds and appreciation for it, but may also cause dirty streets due to birds fouling [6]. Trees offer shading but can block off the light in houses or apartments (Mell et al. 2013).

Trees canopy can be perceived as aesthetically pleasing and valued from an environmental perspective as they decrease pollution levels [6]; however, at the same time, leaf fall can cause annoyance and decrease the sense of safety. Proximity to parks can be also considered as a negative factor, especially if it is considered an unsafe area [49].

The earlier studies suggest that the WTP may vary depending on the supplier of GI. The research implies there is a difference in WTP depending on whether the GI is provided by a municipality/local government or a private developer [13,14]. People are less willing to pay a premium for GI delivered by municipalities than by developers, reasoning that delivering green areas is the responsibility of municipalities/local government [13,50,51].

Mell et al. [6] implied that economic variables which include the effect on local business revenues or expected increases in property value may weigh on the perception of GI and consequently on WTP.

Technologies for Energy Saving

A study in Toronto, Canada, modeled the effect of green roofs on the urban heat island and concluded that they would reduce local ambient temperature by 0.5 to 2 °C. The study calculated that this would result in C$12 m of savings from reduced energy demand for cooling [52], which is a benefit that may lead to higher WTP.

Perini et al. [53] examined vertical greening systems and the effect on airflow and temperature on the building envelope in a Mediterranean climate, and Mazzali et al. [54] conducted studies into the thermo-physical performances of living walls via field measurements and numerical analysis. Their studies estimated savings of 40%–60% of demand for air conditioning. Three out of four Australians had a refrigerated cooler by 2014, and in 2009 in Victoria, the average usage totaled 107 h of air conditioner use in warmer months, with older and unwell people having much higher usage rates: some 10 to 15 times higher [55]. Economic modeling estimated that the average costs for people running air conditioners were between $49 and $66 (based on $0.15 and $0.20 per kWh, respectively). Costs can be up to 64% higher in the hotter areas, such as Queensland and 61% lower in cooler areas such as the ACT.

For 2007, the estimated average cost of cooling for all Australian households was $49–66, which is now approximately $62–84 adjusted for inflation [55]. Another estimate by Sustainability Victoria in 2017 stated that the typical monthly costs for air conditioning in Victoria are $32 per month at the most expensive and at least $2.25 per month [56]. Therefore, applying 50% savings of $16 to the highest costs is possible with green wall retrofitting, so for Melbourne's 4.82 million population based on 75% usage, total monthly savings of $57.84 million are possible. For the lowest cost rate, 50% savings of $1.12 to the least costs are possible with green wall retrofitting, so for Melbourne's 4.82 million population based on 75% usage, total monthly savings of $4.04 million are possible.

Technologies for Improved Environmental and Storm Water Management

Environmental factors may include decreasing pollution levels [6,7,15,51], improvements for water run-off [6,7,15], or the general value of trees [51]. The attenuation of stormwater run-off and pollution are provided with the adoption of green roofs, and a study of Melbourne Australia showed the potential benefits derived from the widespread adoption in retrofits [57,58]. Wilkinson and Torpy [59] examined the potential for absorption of pollutants in Sydney, Australia through the installation of green roofs and green walls, recording positive outcomes in both aspects.

Nature within Reach

The size of, and distance from, GI amenities have significant effects on individual appraisal, utility, and weighting in cost–benefit analysis. A number of studies found that people were willing to pay a premium to increase the coverage of green areas [8,44,47,60,61] and to decrease the distance between household and green urban spaces [8,11–13,43,44,60]. Additionally, a significant relationship was

found between mental health and distance to GI; increasing distance to green urban areas was found to significantly decrease life satisfaction [60,62].

In some cases, the size of a facility was found to be negatively correlated with WTP [11]. This clearly indicates the cost–benefit relationship of urban green spaces; the size of green facilities might be related to health and wellness benefits but may come with costs in the form of increased animals fouling, disturbance [43], or increased traffic or usage [14].

Quality and Aesthetics

Studies showed that WTP might be negative or nil if respondents were dissatisfied with public GI standards, which is practically experienced with municipally owned areas such as parks or walking areas [7]. Mell et al.'s [45] results showed that bearing costs for the maintenance of GI may have a negative effect on WTP.

The quality of a GI facility can be determined by age, as the vegetation in older amenities are more mature, and therefore may seem greener and aesthetically more appealing. The maturity of GI amenities has significant and positive effects on WTP [8]. Mell et al. [6,45] found that transactions in scenarios with higher indices of green, for example, from small trees to large trees or, no grass to patches of grass, increases WTP.

There are additional factors that may be included in the evaluation of amenity qualities; for example, the frequency of use [6], facility size [8], landscape quality [6,45], perceived green factor/saturation [6,45], street attractiveness [51], aesthetics [12,43], shading, and resting possibilities [6].

2.2.2. Physical Aspects of the Dwelling and Infrastructure

When purchasing or renting residential property, people look at the property size and number of bedrooms to suit their needs [38] as well as views from the property, the quality of building materials, and energy efficiency aspects [63,64]. For some people who have medical conditions or allergies to materials or chemicals, it is necessary to avoid residential property or areas where common pollutants such as nitrogen dioxide, carbon monoxide, and sulfur dioxide prevail [64,65]. Other considerations in the decision to purchase or rent a residence are locational, such as proximity to amenities including schools, workplace, shops, and health care [66,67].

2.2.3. Financial Aspects

Flink et al. [68] found that most owners of Swedish dwellings owned them primarily for living, but most of them, to some extent, also own them as an investment. The investment component of property ownership has possibly increased (on average) in Sweden and elsewhere, due to immense, widespread increases in residential values over time in some places. If the buyer of a dwelling to some extent views the purchase as an investment, s/he most likely then presupposes a future gain at some time.

However, this gain is uncertain, and it can also be a loss. It is extremely difficult to evaluate both the degree of uncertainty (usually referred to as risk) and probability, which never exists in the residential market [69,70]. Therefore, we suggest that what may influence the willing-to-pay price is not a specific gain predicted by some probability, but the extent to which one views the purchase as an investment and what one believes about the development of prices of residents in the area or in general.

A buyer ought to take operating costs into consideration, and any fixed fees or charges to be paid on a regular basis, that are known when buying. As to possible fee changes in the future, which should have consequences for the willing-to-pay price, the same reasoning above applies. Such changes are almost impossible to predict, but a perceived extent and direction of such changes may influence the willing-to-pay price. As to the size of installments and interest to be paid, these are in most cases considered by the lender, if a loan is needed for the purchase. In this case, these will limit the loan amount one can get and be part of restrictions in the model. Mell et al. [6] implied that economic

variables, which include the effect on local business revenues or expected increases in property value, may weigh on the perception of GI and consequently on WTP. This also concerns the investment aspect of buying a dwelling.

2.2.4. Psychological or Socio-Psychological Aspects

Distance to Family and Friends

For many potential purchasers and their family members, proximity to other family, relatives, and friends may influence the purchase decision [71]. Levy and Lee [71] found that a wider network of family and friends can influence potential buyers in terms of location, affordability, and economic aspects of the decision to purchase a residential property.

Attachment to the Area

Personal experience was found to have a statistically positive effect on WTP [16], while memory of interaction with nature also affects WTP for the conservation of nature. Residents who are likely to have a close attachment to the area indicate higher WTP for greening of the surroundings [6]. The frequency of visiting a green area [6,10,15,51] had an effect on WTP. The potential usage and perceived function associated with GI differs and may affects WTP; for example, GI can have a recreation function [7,10,51], relaxation function [51], or fulfill needs for socializing [51].

Social and Personal Identity

Other factors that may play a role in WTP for housing is the need to strive for personal or social identity, which some characteristics of housing may contribute to. The concept of identity is defined differently in different types of research e.g., [72–77]. One type of definition refers to an individual's self-image or self-schema, i.e., how one defines or views oneself: self-categorization or group affiliation.

We suggest two types of needs concerning personal or social identity relate to housing. The first is a need for self-esteem [78]: what one wishes to be, live up to, and be perceived as by oneself. For example, this includes perceiving oneself as a person caring for the environment and then possibly valuing GI. The second is a need for being perceived by others in a certain way, which is related to perceived norms of others, as incorporated in the theory of reasoned action [79–81]. Associations activated by housing characteristics may spill over and contribute to how the owner or tenant perceives him- or herself and is perceived by others, and a buyers' expectations of such attribution may affect his, or her, WTP for a specific housing, either positively (a benefit) or negatively (a cost).

Housing characteristics may concern the standard or fashion of the building (style of some specific era or epoch, modern, environmental or GI, atypical, etc.), or type of other people living in the house or in the area. The underlying proposition in this study is that the more a building, an area, or their inhabitants live up to one's needs or wishes as to identity, the more satisfied one will be and thus willing to pay, and vice versa.

Studies have found that such identities, or desires for them, exist in respect of housing. Sadalla et al. [82] found that people related their identities to the interior and exterior of their dwellings. Negative identity aspects of housing—which are viewed as costs in our CBA model—have also been studied (e.g., [83–85]), specifically concerning public housing (e.g., [86,87]). See Kemeny [88] for a more general discussion about the identity issue concerning housing.

2.2.5. Brands and Other Signals

Many aspects discussed above that may be considered individually as costs, or benefits, by consumers in a CBA and may also be communicated and indicated by brands (e.g., [89–92]); in this case, this is mainly by the landlord (if rental apartments), the construction company, or the area (e.g., urban districts well-known for some specific characteristics, whether positive or negative to the buyer). For example, the quality, style, extent or type of facilities, or green aspects of a building, may be signaled

by the developer/construction company brand, and different personal or social identities—or price levels—may be signaled by the landlord or the area brands.

Such brands may either be used instead of, or in addition to, specific characteristics (viewed as costs or benefits). Numerous studies have indicated such brand values related to housing; for example, Benjamin et al. [93] found that branded properties achieved gross rents at least 8% higher than unbranded properties, in addition to hedonic physical characteristics. Roulac [94] found premium prices related to brands, beauty, and utility, where the two latter variables are composed of aspects that could be considered individual costs or benefits in a CBA as discussed above, or which could also be encompassed by the brand, if activated as associations by the brand. The impact of brands on WTP may be positive or negative, depending on the associations they activate and how they are valued by the buyer, and the effect sizes will depend on how much the brands have been marketed or mediated in other ways (e.g., through news or social media) and then internalized by consumers.

2.3. Explanatory Variables: Demand, Needs, and Wants Arising from Demographic, Socio-Economic, and Other Buyer-Related Factors

There is a broad literature in housing research positing evidence that demographic and socio-economic factors have significant effects on WTP. In our model, such factors and some additional person-related factors result in the needs and wants that are the input into a CBA, which in turn results in the WTP price. In the context of GI, some studies found that such variables influence WTP. For example, age has been found to have a statistically positive effect on WTP, indicating that the younger population is willing to pay more for GI [15,16,45,51].

Income was found to have a statistically positive effect on WTP [15,16,51]. A number of studies indicated the significance of education and culture on the assessment of GI. For example, education may affect preferences [7]; however, this preference may not necessarily translate toward higher WTP. Other studies suggested differences in perception of GI based on ethnicity [7,45].

Tenure and building type may express an indirect effect in preferences toward privately or publicly owned GI, adding value and responsibility, which relates to issues of ownership. Factors such as privacy and access may affect preferences and the evaluation of GI. For example, in the case of single houses, a garden represents privacy and the owner's responsibility; on the other hand, parks, grass strips, or trees at streets/walk areas are accessible to the general public. The latter are more common as examples of GI in multi-residential areas and are more valued by apartment buyers/owners compared to house buyers/owners [12]. Consumer marketing literature (see earlier references) reports how the different special interest of consumers affects their willingness to pay for products and services.

2.4. Explanatory Variables: Evaluation Rules and Other Mental Aspects

Consumers seldom perform a complete CBA, carefully weighing all different costs and benefits against each other to arrive at a WTP. Instead, they often use heuristics or decision rules (e.g., [95–101]), or what Simon [102] labeled "bounded rationality". The employment of such heuristics or rules, but also other factors, will affect the CBA process and in turn influence the different perceived benefits and costs on WTP (interaction effects).

An example of an heuristic is cut-offs [103], i.e., setting mental limits for what one will accept or look at, for example a lower or upper limit of the price [104–106], the extent of GI, age of the building, the identity of the housing or the area, the area as such (by name or "brand"), or distance to work or friends. However, such limits may change in the final evaluation process due to psychological or socio-psychological factors in the buying situation, as discussed below.

Other decision rules are labeled non-compensatory or compensatory rules [107–110]. If a buyer employs a non-compensatory rule, the perceived costs of one or more important housing characteristics cannot be compensated by perceived other benefits. To some extent, a cut-off could be viewed as a non-compensatory rule if a limit is passed and not allowed to be compensated by some other benefits. Another such rule is the lexicographic one (e.g., [111–113]), according to which objects—in this case,

different housing or GI alternatives—are compared characteristic by characteristic, starting with the most important.

Another non-compensatory rule, adding to the lexicographic one, is elimination by aspects [114]. When applying this rule, the most important characteristic (evaluation criterion) is complemented by a cut-off restriction before it is employed. Another non-compensatory rule is the conjunctive rule [115,116] in which cut-offs play an important rule. According to this rule, all objects are compared characteristic by characteristic as to cut-off limits. If failing on any criterion, for example the existence or absence of GI, the object is rejected until one object remains.

If a buyer employs a compensatory rule [110,117], objects could be chosen despite not living up to some evaluation criteria, because a weakness, or cost, is compensated by one or more benefits. One such rule is the simple additive rule [118], where one prefers one object before others, if it performs better than other objects for more (as to the number of) evaluated characteristics. If a weighed additive rule is used (e.g., [119,120]), then the importance of different characteristics is considered and weighed for.

In 1759, Adam Smith wrote in his book *The Theory of Moral Sentiments*, "We suffer more . . . when we fall from a better to a worse situation, than we ever enjoy when we rise from a worse to a better. It is more anxious to preserve the advantages which we already possess, than forward to prompt us to the acquisition of still greater advantages." ([121], p 213). This means that humans have a tendency to react more negatively to what they perceive as losses than positively on corresponding perceived gains (in other words, we hate losses more than we love corresponding gains). Kahneman and Tversky [122] labeled this loss aversion, which is included in their prospect theory.

The consequence of loss aversion for a CBA is that buyers may focus more on and react more strongly to costs than to benefits, requiring the benefits to be of a larger magnitude in order to outweigh the costs [123]. However, all costs are not be perceived as losses, but more objectively as just costs. In such a case, loss aversion is not activated. Many times, the perception depends on how the costs and benefits are presented, then being an explanatory or influencing factor in the buying situation. Depending on what is chosen as a reference point in such a presentation, a positive (benefit) or negative (cost) outcome may be perceived as the opposite, thus affecting the outcome of the CBA due to loss aversion, which has been labeled framing effect. [122].

Thaler [124,125] suggested that consumers use mental accounting in their evaluations of costs and benefits, which is a kind of bounded rationality. According to mental accounting, consumers group different types of resources or expenditures into different categories (mental accounts), which are then evaluated separately. However, the accounts may be broad, including many or all types of resources and expenditures, or narrow, including only one type of resource and expenditure, or only resources or expenditures, and they may be defined by different time periods. Since people make different evaluations of losses and gains, the outcome of their CBA depends on how the buyer separate costs and benefits into different mental accounts, and for what time lapses, and which costs are viewed as losses or just costs.

Finally, it is assumed that most housing purchase or rental decision-making processes are characterized by high involvement and extensive problem solving, and thus a rather extensive CBA. However, in some cases, that need not be the case. There may be situations where someone needs housing urgently, for example if they are forced to leave their present housing at short notice (burnt down, evicted by a landlord, suddenly divorced, etc.) where there is too little time or vigor for an extensive CBA. Thus, the urgency of the decision is another factor that may have an interaction or effect (with the CBA) on WTP.

2.5. Explanatory Variables: Psychological Factors in the Buying Situation

Although house buyers are expected to be engaged in a comprehensive CBA of alternatives, some factors related to the buying situation may impact the final decision about the WTP, adding to, enhancing, or partly superseding the impact of the CBA. These factors include perceived competition,

perceived marketing cues, or information and how this is framed or perceived from sources other than marketing.

2.5.1. Perceived Competition: The Winner's Curse

Economic theory assumes that less demand and more supply lowers prices, and greater demand and lower supply increases prices within the restrictions of available resources and the extent of buyer needs. However, many studies have shown that in auctions, the more bidders, the more aggressive the bidding and the greater the probability that the winner—the one bidding the highest—pays more than the rational amount. This effect is called the winner's curse (e.g., [126–128].

Houses or apartments are often sold by some kind of auctioneering, and many studies (e.g., [129–132] show that such methods result in higher prices, and thus higher WTP, than if sold in non-auction ways, for example by private treaty. Thus, the more speculators at a house or apartment viewing, or the more bidders, the higher the WTP. Stevenson et al. [133] found that agents seem to be aware of this, since they over a long period (1979–2004) had lowered valuations for auctions in order to attract more potential bidders.

2.5.2. Reference or Anchoring Prices

Already in the 1800s, Weber [134] and Fechner [135] discovered that people make judgements in relation to reference points following a diminishing value function (i.e., the higher the reference point, the less the marginal perceived value). This means that people become less sensitive at the margin the higher the price (even though they should be more sensitive, since they will have less money left). Tversky and Kahneman [136] labeled it the anchoring effect (see [137,138]).

Since it may be difficult to judge what a reasonable market price of a specific object or GI should be, buyers look for some cues of such—an anchoring price. Such cues are usually provided by the seller or an agent in sales material, or if presenting a budget for GI investments. There are studies showing that the higher such anchoring prices are, the higher the final price and thus WTP (e.g., [139]). Other non-marketing anchoring prices may be found in news media telling about price levels of different housing in different areas, or seen in lists of sold housing, in advertisements concerning other housing, etc.

2.5.3. Price as Quality Indicator

Since consumers are used to, or believe, that products with high quality are more expensive to produce and thus are priced higher than products of lesser quality, consumers typically use prices as indicators of the product quality [140–143], i.e., judging high-priced products to have a higher quality than lower priced products. This is especially the case for products or services of which the quality as such is difficult to perceive, which to some extent concern housing and GI. Thus, it is posited that the higher a communicated anchoring price is, the higher the perceived quality, and in turn, the higher the WTP, although there are always limits to such.

2.5.4. Price Lining

Combining the reference price and price as indicators of quality effects or heuristics has led to the pricing technique price lining, which is a version of product-line pricing [144–146]. Consider three similar products or objects for sale—in our case, three different housing products or proposals for GI investments—of which the quality levels are somewhat uncertain, and which are priced at three levels. Using the price-as-quality-indicator heuristic, buyers will judge the more expensive objects or proposals to be of higher quality than those priced lower, and vice versa. Using the reference point effect, the lowest and middle-price object or proposals will be viewed as less expensive than the highest priced object, and vice versa.

Some consumers who are interested in high quality, or view GI as very important, and who have resources to pay, will choose the most expensive object, while others who are mostly interested

in buying as inexpensively as possible will go for the least expensive object or proposal; however, most people opt for the middle-priced object, since they then get "good, or ok, quality" for a lesser price [147–149]. Each set-up of price lines may be viewed also as a mental account. Since buyers have a tendency to make their evaluations from the relative positions of the prices at hands, instead of the prices as such or other reference prices, they are subject to manipulation if all prices in the lines are increased about the same. Such use of price lining in the marketing of objects, or if it happens to exist anyhow by chance at the time of a sale, is then posited to affect the WTP.

2.5.5. Other Factors in the Buying Situation

There are many other pricing techniques based on psychological mechanisms that may influence the WTP. One is the use of charm listing prices, i.e., prices just below some round number price such as; 99.9 instead of 100 [150]. Others are optional product pricing, captive product pricing, by-product pricing, and product bundle pricing that may be used in one way or another for housing sales (see e.g., [151]). In addition, by describing—framing—housing or area characteristics, in the selling situation, as being "lost" if not choosing the object being considered, loss aversion is activated, which may increase the WTP [123].

A marketing method that is seemingly rarely researched is home-styling, although it has become increasingly used when selling residential properties [152–154]. The main idea is that attractively styled homes will increase the WTP and attract more bidders, which in turn will increase the WTP even further. If there are strong interest in GI among the bidders, such styling is expected to increase the WTP even further. Home styling is very popular in Australia's residential sales market.

2.6. Explanatory Variables: Restrictions

In all buying situations, there are restrictions that set an upper limit as to what is possible to pay, and also to the WTP. To some extent, these are the same as some buyer-related factors that may lead to needs or wants, such as the buyer's income and other financial resources available for the purchase. Due to bank policies or societal regulations, there is often an upper limit of what a buyer can borrow; however, this may be circumvented if the buyer can get private or other loans that are less restrictive (e.g., requiring less or no mortgage).

Sometimes, other financial solutions may be available, such as gifts from parents, friends, or relatives, or by crowdfunding [155] or crowdsourcing [156]. In many countries, there are governmental financial support for investments in GI, for example for energy saving or for solar power, which should have a positive effect on WTP.

3. Conclusions: The Complete Model

This paper has reviewed extensively demand and supply variables and characteristics of residential property, and other variables influencing the willingness to pay for a dwelling or investments in GI. The starting point has been the assumption that a decision about buying or renting a dwelling, including GI, or investing in GI separately, is a high-involvement decision, thus usually resulting in a rather extensive cost–benefit analysis by buyers. As dependent WTP variables, we have focused on;

1. Price for buying a dwelling,
2. Rent for a rented dwelling, and
3. Special fees or charges for specific GI investments.

We have assumed that;

(1) Needs and wants, arising from demographic, socio-economic, and other buyer-related factors (which may be used as proxies for needs and wants), i.e., demand factors, and;
(2) characteristics or attributes of available housing alternatives, or of proposed GI projects, i.e., supply factors, are inputs into;

(3) a cost and benefit analysis (CBA) performed by the buyers. The CBA, or actually, its influence on WTP, is in turn assumed to be influenced by
(4) factors concerning how the CBA is carried out, by evaluation rules and other mental aspects. Despite the outcome of the CBA, the model suggests that at the final stage for decision, still other factors play a role:
(5) Psychological and socio-psychological factors in the buying situation, and
(6) restrictions, limiting what the buyer can pay.

Our conclusion from these assumptions is the rather comprehensive conceptual causal model explaining buyers' WTP for a dwelling shown in Figure 1. The model is based on a presumed cost–benefit analysis performed by buyers, extended to include GI and psychological factors, as presented in Table 1. The conceptual model (Figure 1) may be used to select variables in empirical studies of WTP for GI in residential development and is to be tested in empirical research.

The purpose of this comprehensive model is to make it clear that many different factors are involved in the decision process to buy or rent a dwelling, or invest in GI, and which need to be considered when doing research about such decisions in order to be able to separate possible premiums for GI from other explanatory factors. In applying the model with homebuyers and analyzing responses, alongside residential sales data, assessment of the amount of GI related sustainability in residential property development is possible.

In order to gain deeper understanding of the relationship between the price that an individual is prepared to pay for a property and GI, we need to increase our knowledge on individuals' perception of GI and the role it plays in the consumer buying process. It is important for residential developers, and for policy makers, to better understand what is the WTP for investments in GI and how WTP may be influenced. Our intention is that the conceptual model arrived at in this paper can help researchers, and also practitioners and policy makers in real estate, in such endeavors.

The benefits of GI in urban settlements include improved atmospheric conditions through better air quality, attenuation of the urban heat island, thermal insulation and lower energy bills for green roofs and walls, creation of social amenity space, a habitat for biodiversity, and stormwater water attenuation.

Increasing understanding of the level of GI that a market-led approach can deliver and show what level of GI is required from the public sector. At a broader level, it is important for society to increase GI in our environments to deliver sustainability for current, and future, generations.

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