

Willingness to pay for green roofs and facades in commercial buildings

Nuno Filipe Vaz de Matos Simões

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Given the negative impact due to the progressive expansion of built-up areas into formerly green areas, as well as the increase of population density observed in large urban centers, it became essential to create an environmentally friendly way of life, namely by finding medium and long term solutions of coexisting with nature without endangering the normal balance of its ecosystems. As such, green buildings are a solution of extreme importance, due to its economic, environmental and social benefits. This dissertation's main objective is to evaluate the Portuguese consumers' willingness to pay (WTP) for sustainable solutions, namely green roofs and facades targeting commercial buildings. The methodology used in this study contemplates surveying the population in order to evaluate their declared preferences. Consultation of specialist technicians is also included to further complement the study. The Portuguese population shows a strong WTP for accessible green roofs, revealing that it is willing to pay 5% above the purchase value for a commercial property with this type of solution. Regarding the other systems, the willingness to pay was 3.5% for both indoor and outdoor green walls, and only 3% for inaccessible green roofs. Bivariate analysis of the results, which includes a correlation study by applying the Spearman method, shows that both familiarization with the concept of sustainable solutions, and the satisfaction associated with the number of existing green spaces, are the two factors which most significantly influence the willingness to pay rates revealed by consumers.

Keywords: Green roofs/facades; Willingness to pay; Commercial buildings; Stated preferences

1. Introduction

At a time when it is observed, all around the world, a progressive expansion of built-up areas into formerly green areas, as well as the increase of both population and construction density in large urban centers, it is particularly important to implement

alternative constructive solutions that mitigate the social, economic and environmental impacts inherent to this negative trend (UNFPA, 2015). In this sense, sustainable construction is seen as an imperative solution to provide increasingly populated urban areas, with a healthy

balance between people and the environment.

In fact, a growing number of studies indicate that sustainable buildings provide economic, environmental and social benefits through a variety of mechanisms, including lower operating costs, higher employee productivity, tax credits, and a more attractive building design (Fuerst & McAllister, 2011).

In this context, of sustainable construction, there are two systems of great importance – green roofs and green facades. Both solutions have several advantages, such as reducing the concentration of atmospheric pollution, increased energy efficiency, mitigating the heat island effect and reducing the carbon footprint, reducing the flow of rainwater, aesthetic improvement, and increasing the building valuation (Bianchini & Hewage, 2012; Graceson et al., 2013; Hashemi et al., 2015; Santamouris, 2014; Speak et al., 2013).

The vast majority of studies on green roofs and facades focus mainly on:

- detailed analysis of these systems' technical performance (particularly thermal and hydric components);
- functional requirements of both solutions;
- applied construction methods;
- maintenance requirements;
- the most frequent pathologies;
- and in-depth analysis of the benefits inherent in the implementation of these systems, whether in new buildings or existing buildings (rehabilitation).

However, there is a lack of studies that evaluate and quantify how the population really values this kind of constructive solutions, as well as its benefits. Therefore, this work arises in order to assess the Portuguese consumers' willingness to pay for sustainable solutions, namely green roofs and facades in commercial buildings, in order to respond to the scarcity of studies in this specific area.

2. Willingness to pay

2.1. Concept

The concept of willingness to pay (WTP), refers to a given individual's availability to pay for something, that is, quantifies how an individual values the object or factor under study. It is usually expressed as a percentage of the value of object under study.

In the context of green roofs and facades, it is convenient to consider the value of real estate to evaluate how the population values this type of constructive solutions, since these introduce several direct and indirect benefits, either by increasing the coatings' life cycle, by optimizing the useful space or simply by the aesthetic improvement of the building. In this sense, this work evaluates how the population values these benefits, determining their predisposition to pay above the acquisition value for a property integrating such systems.

State-of-the-art WTP studies for green roofs and facades show that the population's willingness to pay for this type of solutions is

usually between 0% and 5% (Banfi et al., 2008; Hu et al., 2014; Nurmi et al., 2016; Robinson et al., 2016; Vanstockem, 2016; Wiencke, 2013; Xie et al., 2017; Zalejska-Jonsson, 2014).

2.2. Methods of measuring WTP

There are several ways of measuring the willingness to pay. In a simplified way, these methods can be divided into two main groups according to the type of information they use to calculate the WTP: methods that evaluate revealed preferences and methods that evaluate stated preferences.

Market data analysis are the most common revealed preferences methods and consist in the collection of information through observed data. The use of this kind of methods is based on the assumption that past searches can be used to predict future market behavior. In general, the use of market information has the advantage of analyzing actual data observed in reality, rather than data from stated purchase intentions. The major disadvantages lie in the fact that price variations in the observed data are usually very limited, and also in the impossibility to estimate the WTP for entirely new products, because there is no data (Völckner, 2006).

Direct surveys are part of the WTP measurement methods that evaluate stated preferences. These can be divided into two groups, those involving consumer surveys and those using expert judgments. Consumer surveys, as the name implies, collect information directly from the population. Surveys can be face-to-face or

online. In them, the respondents are asked to directly attribute the price, which they think is fairer, to the product under analysis. On the other hand, the experts judgments emerge as a faster alternative, since it consists in consulting a restricted group of specialists in the area under study, who project the expected WTP values (Breidert et al., 2006).

2.3. Choice of WTP method

In the context of this study, which aims to evaluate the predisposition of the Portuguese active population to pay for green roofs and facades in commercial buildings, the use of methods associated with revealed preferences to obtain values of willingness to pay is not feasible. This impossibility is due to the fact that no information is available on all real estate transactions containing at least one of these types of constructive solutions in Portugal. Thus, there is no way to compare the transaction price of these properties with sustainable properties with similar properties (area, location and typology) with current constructive solutions. Otherwise, it would be possible to estimate accurately the willingness to pay values by calculating the average of the transaction differences between comparable properties, divided by the market value of the current solutions property. Therefore, it becomes evident that the only possible analysis for this case study is through methods associated with stated preferences.

3. Methodology

The methodology used in this study was based on the evaluation of declared preferences, through direct surveys of the population, and then complemented by consulting a selected set of specialists in the area of sustainable construction, in order to validate the originally obtained results. Finally, the WTP for both green roofs and facades in commercial buildings were analyzed in relation to several personal characteristics of the respondents (eg, gender, age, education level, and income) to determine if there were any correlations. The Spearman's rank correlation coefficient was used to calculate those correlations (which is a nonparametric measure applicable for both continuous and ordinal variables).

3.1. Consumer Survey

This questionnaire is intended for the active Portuguese population and is divided into three sections: characterization of environmental affinity, characterization of willingness to pay and individual characterization.

Survey Structure

The first section, made up of four questions, aims to determine the degree of population's awareness for environmental factors, such as its level of satisfaction with the number and area of existing green spaces, and also if it is familiar with the concept of facades and green roofs, as well as with their associated benefits.

The second section consists of a set of five questions and intends to determine the willingness to pay respondents for green roofs and facades in commercial properties (dependent variables of the case study).

The design of the questions related to the WTP values took into consideration the review of the literature of the specialty. Since it was possible to verify that the willingness to pay values for this type of solution never exceeded 5% in any of the analyzed studies, it was considered acceptable to define response intervals up to double that value, that is, 10% of WTP. Thus, the WTP response hypotheses were varied from 0% to the "more than 10%" interval, establishing intervals of 2.5%.

Finally, the third, and last, section is composed of eight questions related to the characterization of the individuals (independent variables of the case study).

Target audience selection

The target audience for this survey was the active population living in Portugal. Since the present study seeks to assess the willingness to pay for green roofs and facades in commercial real estate, it was decided to inquire this population group since the respondents, by working daily in office buildings, hotels, restaurants or industrial buildings, can be more sensitive to the benefits introduced by this type of constructive solutions in their respective places of work.

The obvious choice to restrict the survey only to specific investors in commercial real estate in Portugal would not be feasible, as

it wouldn't be possible to obtain a representative sample to estimate reliably the willingness to pay values.

Data Collection

The survey was built on the Google Forms platform and was distributed by email to various companies. The considered companies relate to commerce, hotels, industry, construction, and banking institutions, with a concern to make a wide selection to cover the entire Portuguese territory. Thus, it sought to ensure that the sample was as heterogeneous as possible in order to avoid biased responses. Of all the contacted companies, a response rate of approximately 60% was obtained. This survey lasted more than 3 months and was available for online filling from the beginning of January 2018 until the second week of March of the same year. Finally, the total number of responses obtained at the end of the survey activity period was 203, two of which were excluded due to incorrect completion, thus considering a final number of 201 valid answers for the future analysis.

3.2. Expert Consultation

Consultation with specialists is part of the complementary methodology adopted for this case study. This consultation was carried out through an online survey for specialists in the area of sustainable solutions, namely green roofs and facades, with the main objective of validating the results obtained in the survey of the active Portuguese population.

Structure of the survey

This survey is divided into three sections. The first section of the questionnaire consists of four questions concerning the average willingness to pay values that, from the experts' perspective, are expected to be obtained from the Portuguese population with regards to green roofs (accessible and inaccessible) and green facades (indoor and outdoor).

The second section is a set of nine questions, eight multiple choice and one open answer, which seek to characterize the current panorama of green roofs and facades in the Portuguese real estate market. This section focus on the growth rate, degree of implementation and type of buildings where these constructive systems are usually implemented.

The third section has four questions (three multiple choice and one open answer) and aims to enquire which main measures, in the opinion of the experts, would significantly increase the use of green solutions in Portugal. Finally, a complementary section is presented, composed of four personal questions that aim to characterize the respondents.

Target audience selection

The target audience for this survey was a selected group of experienced technicians with activity in the area of building sustainable solutions, including green roofs and facades. The justification for this choice lies in the main objective of conducting this survey - the validation of data obtained from population surveys. Such validation in this

way is only possible through specialized entities with recognized experience in this area. In this sense, a set of technicians, among specialty engineers and architects, that fit into this profile was selected. The selection criteria was based on the satisfaction of one of the following factors: working in the area for more than 5 years or having scientific contributes published in the area.

Conducting the survey

The present survey was built through the Google Forms platform and was distributed by email to the previously selected technicians, according to the stated criteria. The investigation lasted more than two weeks and was available from 12 February 2018 until the end of that month. In total, ten technicians who met the selection criterion were contacted, with a response rate of 50%. From the five answers obtained, all were considered valid for the future analysis.

4. Results

In the univariate analysis, it was possible to verify that the WTP values attributed to both green roofs and green facades were consistent with the values verified in the review of the literature, with willingness to pay values between 0% and 5% for this type of solutions.

In addition, it was observed that the WTP values for facades and roofs follow a similar trend, with slightly higher average predisposition values for green roofs (3.85%) than for green walls (3.40%). This is

explained by the willingness to pay obtained for the accessible roofs that presented the highest WTP in this analysis (4.84%). Table 1 summarizes the WTP values obtained for each of the systems considered.

Table 1 - WTP average values for each system

<i>Average Willingness to Pay</i>			
<i>Green Roofs</i>	3.85 %	<i>Inaccessible</i>	2.85 %
		<i>Accessible</i>	4.84 %
<i>Green Walls</i>	3.40 %	<i>Outdoors</i>	3.41 %
		<i>Indoors</i>	3.38 %

The results of the consultation of specialists reinforce the consistency of the willingness to pay values obtained, since they consider that the most valued solutions would be the accessible green roofs (8.8%), and that the least valued of the four systems would be the inaccessible green roofs (5.3%). This trend was effectively verified in the consumer survey, although with significantly lower average WTP values (4.8% and 2.9% for accessible and inaccessible green roofs, respectively).

Still in the univariate analysis, it was possible to verify that 70% of the population doesn't know the benefits associated to the green roofs and facades, nevertheless, more than 50% of the respondents revealed to be willing to pay more for such systems. This situation reveals that the population tend to privilege the visual aspect to the functional aspect of green solutions. Fact that was also referred by the experts, who pointed out the improvement of the aesthetics of the building as the main factor of motivation of the consumers to implement these systems. In

the comparison between the willingness to pay obtained for the two systems considered as green roofs, a significant difference was observed, since the population revealed a predisposition to pay 4.84% above the market value for having accessible green roofs, while to have inaccessible green roofs, the population assumes that would not be willing to pay above 2.85%. This discrepancy of WTP values evidences the high importance of the accessibility factor in green roofs.

Regarding the results of the bivariate analysis, it was found that the population with greater information regarding green roofs and facades tends to attribute higher values of predisposition to pay more for this type of solutions. The Spearman correlation analysis reinforced the validity of these results, since it was the variable "familiarization with the concept", which presented the highest correlation value with the willingness to pay of the population. It should be noted that the experts also pointed out the knowledge about the real benefits of green solutions as the variable that would have the greatest influence on WTP values.

Concerning the "satisfaction with green spaces" variable, it was observed that, as expected, those who were more dissatisfied with the scarcity of green areas, attributed higher WTP than the rest of the respondents. Once again, the correlation analysis by Spearman's method confirmed this relationship, since this variable presented the second-best correlation with the WTP values obtained.

As for the location variable, the results obtained reveal a linear relationship

between the WTP values and the location of the respondents, where individuals residing in Lisbon and Oporto tend to assign mean WTP values lower than the respondents belonging to the remaining Portuguese districts.

In which concerns to the "educational level" variable, it was possible to observe the existence of a linear relationship between the mean values of WTP attributed in the various categories of this variable, where respondents who completed the secondary, attribute systematically the lowest values of WTP, while individuals with higher education have a higher willingness to pay above market value to have sustainable solutions.

With regards to the average monthly income, it is worth noting that, contrary to initial expectations, individuals who earn more than € 2,000 did not reveal a greater predisposition to pay above market value than the others respondents for any of the four green analyzed solutions.

Regarding the variable "relation with the company", it was not possible to observe significant differences in the average values of WTP attributed by employees and partners of companies. However, the predisposition to pay above market value for sustainable solutions was slightly higher for business partners (average difference of approximately 0.2%).

Concerning the "business branch" variable, it was not possible to observe any trend evidenced in the willingness to pay values according to the different business areas considered. It is noteworthy that individuals associated with commercial companies attributed the highest WTP values to both

Table 2 - Summary of preferences observed for the variable "business branch"

	SERVICES	HOTELS & RESTAURANTS	TRADE	INDUSTRIAL	CONSTRUCTION
INACCESSIBLE GREEN ROOF	0	--	++	+	-
ACCESSIBLE GREEN ROOF	--	++	-	+	0
OUTDOOR GREEN FACADE	--	+	0	-	++
INDOOR GREEN FACADE	0	-	++	--	+

0 = Intermediate WTP

-- = Lowest WTP value

++ = highest WTP value

- = low WTP value

+ = high value of WTP

the inaccessible green roofs and the indoors green facades. While in the case of accessible green roofs, it is the individuals connected to hotel and restaurants companies that are more predisposed. Finally, it is verified that individuals linked to construction companies are the ones that value the outdoor green facade systems the most.

Table 2 outlines the distribution of the preferences revealed by each category (branch of the company) in each of the constructive systems analyzed. Finally, in consultation with experts, they were unanimous in highlighting the implementation of incentive/ tax benefit policies and the need to provide information to society about the advantages inherent to the use of green roofs and facades, as the main measures that would increase the predisposition of the Portuguese population to pay for these constructive systems.

5. Final Considerations

It is concluded that the population has a greater predisposition to pay for accessible

green roofs, corresponding to the average of 4.84%. That is, the population assumes that it would be acceptable to pay, practically, 5% above the market value to acquire a property with this type of constructive solution. With respect to the other systems analyzed, it is concluded that both green facades (indoor and outdoor) have similar predisposition values, about 3.5%. While for the inaccessible green roofs the population does not reveal being willing to pay more than 3% above the market value of the property to incorporate this solution.

Analyzing the green roofs together (accessible and inaccessible), it was possible to observe that they present an average WTP of 3.85%, whereas for facades the average WTP was 3.40%.

Through the univariate analysis, it was possible to observe that the population tends to favor more the visual aspect of the green solutions than its functional performance. It was also found that there is a general lack of knowledge about the benefits introduced by these sustainable solutions. It is therefore concluded that one of the most important

measures that would lead to an increase in the population's predisposition would be to provide information or even practical demonstrations of their performance. In this study, it was also evident the high weight factor 'familiarity with the concept of sustainable construction', since those who assumed to be knowledgeable of this concept showed greater willingness to pay for these solutions.

The results show a linear relationship between the WTP values and the location of the respondents, where individuals living in Lisbon or Oporto (large urban centers) showed WTP values lower than the WTP values attributed by respondents belonging to the other Portuguese districts.

Through the bivariate analysis, it was possible to identify a linear relationship between the education level and the WTP values, where individuals with higher education have a higher average predisposition to pay above market value to have these constructive solutions. Regarding the entrepreneurial relationship of the respondents, there was a greater predisposition for business partners (a difference of approximately 0.2%) for all solutions. As for the branch of activity of the company, it was observed that individuals associated with hotels and restaurants assumed higher WTP values, which indicates the potential for greater use of these solutions in this type of real estate.

Finally, through the correlation analysis by the Spearman method, it was possible to conclude that the variables that present the greatest influence on the willingness to pay of the population are "familiarity with the

concept", "satisfaction with green spaces" and "education level". Also, the variables "gender", "location" and "average monthly income" should not be discarded, since they revealed to be of considerable relevance in the analysis performed. On the other hand, it is possible to affirm that the variables "company size", "relation with the company" and "branch of activity of the company" do not have significant influence on the variation of WTP values obtained, since they have global correlations of weak intensity.

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