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When Residential Energy Labeling Becomes Irrelevant: Sustainability vs. Profitability in the Liberalized Chilean Property Market

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Abstract: The study of the relevance of energy efficiency attributes on residential choices is usually based on stated preferences, using performance indicators. However, this issue has not been researched in developing countries, where energy certification schemes have a low adoption rate. This article paper uses a methodology based on a Kansei Engineering and Kano Model to identify home buyers' energy performance perceptions in three real estate developments in Santiago de Chile. Surprisingly, energy ratings negatively affected the survey respondents' willingness to buy. On the other hand, the ratings indicated that the most relevant attribute for influencing the purchasing is the perception of the home as a good investment. This finding contradicts most of the studies on energy certification and shows the relevance given to the profit of purchasing new housing units. Therefore, the analyses suggest that this situation represents a decoupling of consumer perception from both the items measured by energy labels and their contribution to consumer choices.

Keywords: energy efficiency; energy labeling; profit; Kano model; Kansei Engineering

1. Introduction

The study of the relevance of energy efficiency attributes in residential choices is usually based on stated preferences, which can be classified into two groups: (1) those that study architectural attributes in isolation, that is, the one-off substitution of these attributes in a current dwelling; and (2) those that study architectural qualities comprehensively, that use energy or environmental efficiency certification programs as a synthetic overall performance indicator. An example of the first group is the study by Poortinga et al. [1] that juxtaposes the importance of making changes to heating and lighting systems with changing energy consumption habits. Achtnicht and Madlener [2] found that energy improvements are only made when there is a need to replace systems or to make functional repairs. Additionally, Reynolds et al. [3] explored the contrast between the self-reported willingness to pay and the actual purchase behavior in the market for compact fluorescent light bulbs in the Caribbean

island nation of Santa Lucia. Studies in the second group are much fewer in number, but three of them stand out. Heinzle, Boey Ying Yip, and Low Yu Xing [4] performed a conjoint analysis to determine the extent to which households in Singapore prefer homes based on their level of Green Mark program certification. Marmolejo-Duarte and Bravi [5] used the same methodology in their study on the relative relevance of energy efficiency in the choice of homes for rent and purchase. To do so, they used three different efficiency ratings from the Energy Performance Certificates (EPC) rating scheme as a synthetic indicator. Their results indicate that if people are informed of both the EPC ranking and its economic and environmental repercussions in easily understood terms, energy will emerge as the most relevant attribute compared to other features related to the quality and functionality of a home. Lee et al. [6] showed that energy efficiency has a significant effect on consumer decisions to buy or rent a home when they are given appropriate information from the energy labeling used in South Korea. Finally, Khan, Thaheem, and Ali [7] carried out a hierarchical Bayesian model of adaptive choice-based conjoint analysis to study the determinants on willingness to pay for sustainable housing. Similarly, their results show that energy savings has the highest relative importance in comparison to other housing attributes.

Conversely, other studies suggest that energy efficiency attributes are subsumed to the economic efficiency of the investment. Sadler [8] found that people are only willing to make energy-related improvements if profitability is high, that is, if they can quickly recover the associated capital expenditure. Studies by Banfi et al. [9] and Kwak et al. [10] similarly demonstrated that the willingness to pay for energy improvements depends on the perception of their marginal contribution (for example, people are more willing to install double-pane windows than to improve building envelope insulation). The profitability of investments for housing is particularly sensitive to the willingness to purchase in contexts where strict private-property schemes operate in the provision of dwellings and where social security has been privatized by neoliberalization processes [11–13]. The neoliberalization of housing was particularly intense in the case of Chile, where all the provision of dwelling was privatized since, from 1979, most of the new developments are profit-driven [14]. In a case of extreme neoliberalism such as Chile's, it is relevant to learn whether consumers are aware of the importance of energy efficiency for purchasing housing or if the profit-driven logic remains as the main criterion for decisions even when the country is highly exposed to the environmental effects of climate change [15,16].

To address the question of how consumers valorize the sustainability of a project concerning its profitability, this paper presents an analysis of stated preferences regarding energy efficiency attributes. This study is relevant, given that the willingness of consumers to purchase housing regarding energy certification models is scarce in developing countries. Indeed, these schemes have only been recently applied, or have had meagre adoption rates. However, understanding the barriers related to the knowledge gaps in developing countries constitute one of the significant challenges in the field of sustainable construction, as it was declared by the review papers by Darko and Chan [17] and Darko et al. [18]. Moreover, the study sheds light on the relationship between the economic features of a development and its sustainable characteristics. Thus, this research tries to provide evidence about the preference of consumers in the Chilean real estate market at a time when the country is debating the need for mandatory energy-efficiency ratings for homes as well as demanding more affordable housing. To achieve this objective, we developed a survey and analyzed perceptions of these attributes and their relative impact on the importance of the willingness to buy in three actual cases of real estate developments in the city of Santiago de Chile, which, as the capital city of the country, concentrates the 45% of the population [19] and 57% of the housing supply from the national property market [20].

2. Materials and Methods

2.1. Chile's Regulatory Framework for the Energy Efficiency of Housing

The real estate market in Chile is undoubtedly a liberalized market as defined by Roca [21,22]. In this type of market, any negative externalities for the city, its neighborhoods, or homes themselves are expected to be resolved through competition and compensation for housing developers, assuming that

market forces can distribute resources in the most efficient manner. These Chilean neoliberal policies, that began with the National Urban Development Policy during the military dictatorship—and were called “modernizations” by their supporters—had a significant impact on the market for land (increasing prices), defined the growth model for the major Chilean cities, and “profoundly constrained the application of urban planning instruments” [23]. Santiago de Chile was sharply modified by these neoliberal reforms, which can be characterized by the concentration of power and the influence of capitals over policy design [24]. The socio-spatial segregation processes based on the payment capacity, where high prices tend to be concentrated in space, represents a direct consequence of this situation [25].

However, Chile was one of the first Latin American countries to adopt mandatory energy regulation for housing intended to “improve the quality of life of the population through improved thermal comfort” [26]. Indeed, maximum allowable roof thermal transfer values were established in 2000, and in a second stage, additional requirements were nationally imposed on roofing, perimeter walls, and ventilated floors, in 2007 [27]. However, according to the World Bank, this regulation can be considered “relatively lenient in comparison to international state-of-the-art” requirements [28]. Such a report shows the maximum allowable thermal transfer through walls in Santiago de Chile (corresponding to $1.9 \text{ W/m}^2\text{K}$) in comparison to Portugal (with a similar number of heating degree days), which imposed a requirement of $1.2 \text{ W/m}^2\text{K}$ in the mid-1990s. The OECD highlighted the same issue, strongly recommending stricter thermal envelope standards to “improve the quality of housing and protect public health” [29]. Furthermore, although Chilean experts consider these standards to be an initial designation, the consensus is that they remain insufficient to make a useful contribution to home energy efficiency [30–33] and that they have not been updated in more than ten years. Accordingly, the Ministry of Housing and Urban Development proposed updated regulations in 2014 with standards that significantly improved upon existing ones [34], which until September 2020 had not yet been approved. For example, in Santiago, the maximum allowable thermal transfer through walls was proposed to change to $0.6 \text{ W/m}^2\text{K}$.

At the same time, an “energy rating” system was implemented in Chile in 2013; this system is an instrument that assesses the energy efficiency of a home by considering hot water consumption, lighting, and heating. The rating system issues a label (Figure 1) that is similar to the Energy Performance Certificates (EPC) of the European Union [35] and has letter ratings from “A+” (most efficient) to “G” (least efficient). However, this “A+” to “G” rating ladder contradicts the European Community’s latest recommendations regarding energy labeling, since “ratings using letters A to G are the most beneficial for customers” [36], eliminating the need to include the ratings “A+”, “A++”, and “A+++” that started to proliferate in Europe. In addition to this, class “E” represents the standard for new construction from the current regulations in the Chilean case. At the same time, an energy efficiency seal was established with the aim of providing “easily understood information for dissemination” [37], that is, information on heating and cooling demand (both expressed in annual kWh/m^2) and the percentage of energy savings compared to a reference house without showing the energy rating (letter) achieved. While this supports the idea that there would be a rational, cost-benefit type of approach associated with the home purchase decision, it is contradictory with the aim of “increasing transparency regarding energy efficiency in the real estate market” [35], that was explicitly stated for European EPCs. Here, the communication of the energy rating (letter) achieved is fundamental for objectively and clearly informing the user of the house’s energy efficiency. It is fundamental because the EPC policy conceptually responds to the idea that the use of an energy efficiency communication tool would represent a market driver [38]. The assumption is that consumers will rationally act when buying or renting a property if there is a perceived economic benefit [39]. The intent is to address information asymmetry, one of the leading market failures related to energy efficiency in buildings, given the consumer’s difficulty in empirically evaluating construction quality and its attributes beyond what the seller communicates [40–42].

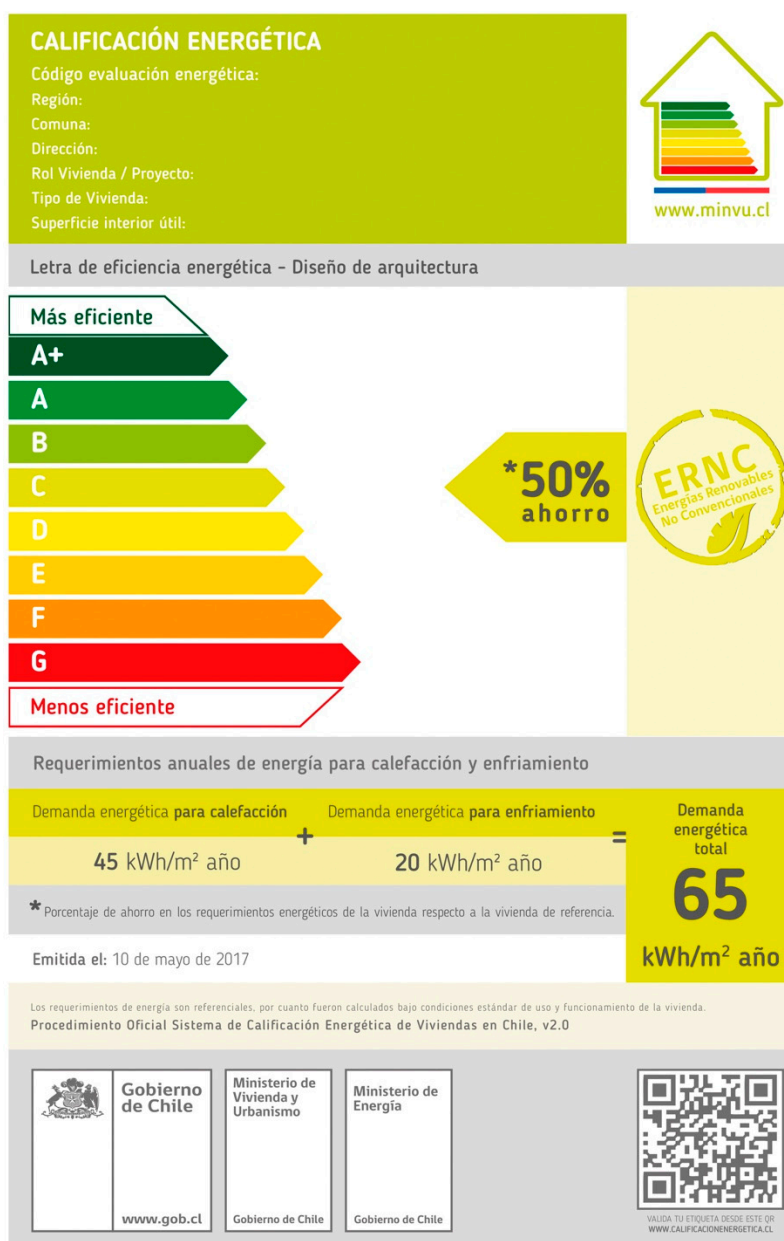


Figure 1. Example of a Chilean energy efficiency rating label for a class C project [37]. Translated terms: Energy Rating (*Calificación Energética*); Energy rating class—Architectural design: 50% savings (*Letra de eficiencia energética—Diseño de arquitectura: 50% ahorro*).

Indeed, the energy rating system has been applied voluntarily so far, although it is expected to become mandatory with the imminent ratification of the “Energy Efficiency Law” [43], which was submitted to the Senate for processing on 4 August 2018. The debate on this proposed law included a presentation of the perspectives postulated in this article. The approval of this law might address the inconsistency of the current regulatory policy, which, on the one hand, requires developers to incorporate energy-related requirements, and, on the other hand, allows them to decide whether to certify the contribution of these improvements to the energy efficiency of the homes. Furthermore, the proposed law is expected to overcome the private marketplace’s minimal adoption of this instrument. In effect, during the first five years of implementation, only 11% of the final ratings issued (for homes with the municipality’s final approval) correspond to the private market, which accounts for 1365 homes throughout Chile [44]. This amount is insignificant compared to the real estate market’s total inventory, which at the national level has ranged from 70,561 to 101,659 units for the same period [45].

From a real estate perspective, energy labeling allows a property for sale to effectively differentiate itself from the rest of the market, since it can generate a green market premium. Thus, the promotion of buildings with higher energy efficiency standards is pursued, since it is understood that the cost avoidance from lower energy consumption has a positive effect on consumers' willingness to pay for these efficiency measures. This effect leads to higher prices to compensate for production costs and encourages real estate developers to develop properties that meet high energy-efficiency standards. Concerning the EPC, some studies based on revealed preference methods have noted up to 4–5% increases in the selling prices of homes with the best energy ratings in some European cities [46–50]. This effect cannot be verified in Chile's case using the same method due to the limited number of certified homes [51]. However, other studies based on stated preferences methods or that directly try to collect the consumer perception (such as surveys or interviews) have shown that this impact is very low, or even marginal [52–56]. One of the causes of this contradiction would be the possibility that the contribution of energy labels in hedonic price models could be hiding other variables, such as the construction quality [57,58], or would present some selection bias [59].

2.2. Use of the Kansei Engineering and Kano Models to Study the Role of Real Estate Attributes

As noted in the introduction, the relative importance that consumers place on energy efficiency attributes is contingent on their perceptions and, ultimately, on the perceived utility of those attributes. Therefore, this study applies the Kano model combined with Kansei Engineering to identify: (1) the relationship between energy efficiency attributes and the willingness to buy a home, and (2) how these attributes are perceived by a sample of potential home buyers. Kansei Engineering attempts to discern the most emotional perceptions that guide consumer behavior [60,61]. The basic idea is to use quantitative techniques to capture multidimensional concepts derived from the interaction of several attributes. Furthermore, the Kano model aims to identify the role of attributes in the willingness to use or buy a given product [62]. This model assumes that the perceived characteristics of a product can have three primary roles:

- Exciting: attributes that, when absent, do not affect the willingness to use/buy a product; however, when present, they trigger a significant increase in this willingness.
- Linear: attributes that are directly correlated to the willingness to use/buy a product; the more of these attributes there are, the higher the willingness to use/buy the product.
- Basic: attributes that, when absent, will cause the consumer to reject using/buying a product; however, when present, they do not increase willingness to use/buy the product.

Although these methodologies have been widely used in market research, they have also been applied to construction and urban planning. Kinoshita et al. [63] used Kansei Engineering to analyze the color landscape of human-made environments. Jennings and Cain [64] applied it to the design of soundscapes, and Lee et al. [65] used it for street design. Llinares and Page [66,67] took it a step further by hybridizing the two techniques from a practical application perspective and applying them to the study of the perceptions of potential buyers evoked by new residential developments. In doing so, they found that concepts such as durability, design/elegance, and quality are determinants of the willingness to buy. Some are basic (e.g., privacy), others are linear (e.g., durability), and others are exciting (e.g., elegance). This same hybrid approach was used by Marmolejo-Duarte and Villar Llull [68] in their study of urban regeneration areas in Barcelona, and by Hartono and Chuan [69] and Tama, Azlia, and Hardiningtyas [70] in their studies of products and services, respectively. As seen, none of these studies addressed energy efficiency or sustainability, as this study does, as described below.

The first step in this methodology consists in identifying the words that best describe the concepts for which perceptions will be evaluated; these are called Kansei words [71]. These words are usually collected from widely circulated magazines, business newspapers, and sales agents information, as they relate to consumer perception and must be synthesized to select the most relevant words. In this research, we studied all of the Santiago real estate advertisements published in *Vivienda & Decoración*

magazine of the *El Mercurio* newspaper and the *Casas* supplement of the *Publometro* newspaper between January 2012 and July 2017. *El Mercurio* is a newspaper with national circulation, while *Publometro* is delivered free within Santiago's metropolitan area. Overall, 8255 advertisements were identified and recorded in a database that enabled a descriptive and longitudinal analysis described in Encinas, Aguirre, and Marmolejo-Duarte [72]. Using this data, all the real estate attributes in the advertising were identified, both those explicitly stated in the text and those suggested by the images. Based on this approach, nine critical concepts related to sustainability (and more specifically to energy efficiency) that are often used as real estate sales pitches were identified, along with other ideas related to design and the general concept of quality. Although the approach typically used in Kansei Engineering is the semantic differential scale [71], the alternative proposed for these nine Kansei words supports the notion that each word pair constitutes a "continuum" [73], that is expressed in a sentence in this case. This approach is very appropriate for a hybrid Kano model, in which the proper categorization of attributes should be based on the provision (or lack) of these data instead of performance criteria [74].

A survey was developed based on the previously identified attributes that used the Likert scale to measure the agreement regarding the presence of the features in the stimulus presented. The nine considered attributes correspond to the following sentences:

- "This is a high-quality building."
- "This building seems to be thermally comfortable."
- "This building is a good investment because of its sustainability features."
- "This building stands out from the others".
- "This is a good building because of its public amenities."
- "People aware of environment conservation would live in this building."
- "The energy efficiency label helps make a buying decision."
- "This building enables savings on electricity and gas bills."
- "This building has windows that reduce energy consumption."

The survey also collected sociodemographic data (age and education level), along with self-perceptions of knowledge about the energy certification of Chilean homes. Finally, similar to Llinares and Page [67], a global evaluation variable about willingness to buy was added to the questionnaire as follows: "Assuming that your budget allows it and that you find the apartment you are looking for, how willing would you be to buy an apartment in this building? (on a scale from 1 to 7, where one is low, and seven is high)".

2.3. Application of the Attribute Perception Survey in Three Case Studies from Santiago's Real Estate Market

Unlike regular practice when applying these techniques, the stimuli used here are not theoretical or reproduced; instead, they come from actual real estate developments in Santiago's residential market. To remain consistent, and since the objective of this research was to examine emotional perceptions of real estate sustainability attributes, three real estate developments were chosen as case studies. The multi-family housing market was selected for the analysis, given the preponderance of this housing type over single-family houses (between 70% and 90% of the total over the last 15 years). Besides, projects targeting the middle-income segment were selected, since the reduction in consumption (expense) of heating, electricity, or hot water that may be achieved from several of the energy efficiency real estate attributes is particularly relevant, as described in Encinas, Marmolejo, and Aguirre [75]. When housing prices exceed this range, several characteristics become part of the expected construction standard (for example, double-pane windows), thus diminishing their capacity for differentiation, and others emerge that appeal to a more highly valued and subjective aspect of sustainability [76,77].

Thus, the survey was applied to potential homebuyers who made uninvited visits to the sales offices of three multi-family real estate development projects in Santiago de Chile between July and October of 2017, producing 124 completed surveys (Table 1). Since some of these months coincide with the winter season, it would be expected that respondents would consider the attributes related to

thermal comfort or heating costs. These three projects have been energy-certified and represent similar market niches. Once the participants had been informed of the sales promotions and had visited the model apartment, they were asked to complete the survey on a face-to-face basis.

Table 1. Description of the three housing development projects in which the survey was conducted.

	Project 1	Project 2	Project 3
Number of apartments	250	20	144
Number of stories	16	5	18
Lowest unit price (from)	US\$80,000	US\$140,000	US\$120,000
Smallest living area (from)	37 m ²	62 m ²	60 m ²
Largest living area (to)	59 m ²	120 m ²	83 m ²
Maximum number of bedrooms	2	3	3
Maximum number of bathrooms	2	2	2
Apartment type	Normal, duplex, triplex	Normal, duplex, triplex	Normal
Energy efficiency rating	D	Between A and G	Rated but not published
Sustainability attributes	Thermal solar collectors, photovoltaic panels, thermal insulation, efficient devices for water conservation	Thermal insulation, fully electric equipment, double glazing, house openings according to orientation	Thermal solar collectors, exterior insulation finishing systems, double glazing, efficient devices for water conservation

2.4. Methodology for Results Analysis Based on Kansei Engineering and the Kano Model

A re-coding was conducted for each attribute (Kansei word) evaluated. Thus, when the respondent perceived that an attribute was utterly absent from the real estate development used as a stimulus, it was given a value of -2 . Inversely, if the respondent perceived that the attribute was completely present in the development, it was given a value of $+2$. The other two ratings were assigned values of -1 (somewhat disagree) and $+1$ (somewhat agree). In short, this re-coding enabled us to sort the perceptions of the absence/presence of each attribute. Based on this information, the Kano model was built, and its space was derived.

When analyzing the Kano model space, one needs to define the geometric points on which to establish the relationships between the attributes and their impact on the decision to purchase the real estate product. To this end, the Spearman correlation was calculated between the perception of the presence/absence of each attribute and the general willingness to buy the home (Figure 2). The relevancy of each attribute was determined by whether it was above or below the average positive correlations that are statistically significant. As such, attributes with correlations that have the expected sign (positive):

- and are significant and highly relevant when the attribute is present (but not when absent) are of the “exciting” type;
- and are significant and moderately relevant when the attribute is present (but not when absent) are of the “linear” type;
- and are significant when the attribute is absent (but not when present) are of the “basic” type.

However, when the correlations are reversed and significant when the attribute is absent, it is a “reverse” type of attribute. Therefore, when the product attribute decreases the attractiveness of the product, it is a type that should be removed from the product at all costs [78]. Next, it is explained how problematic this statement became when the principal attribute studied (and that from the study’s perspective is interesting to promote) comes into question by being inversely correlated to the willingness to buy.

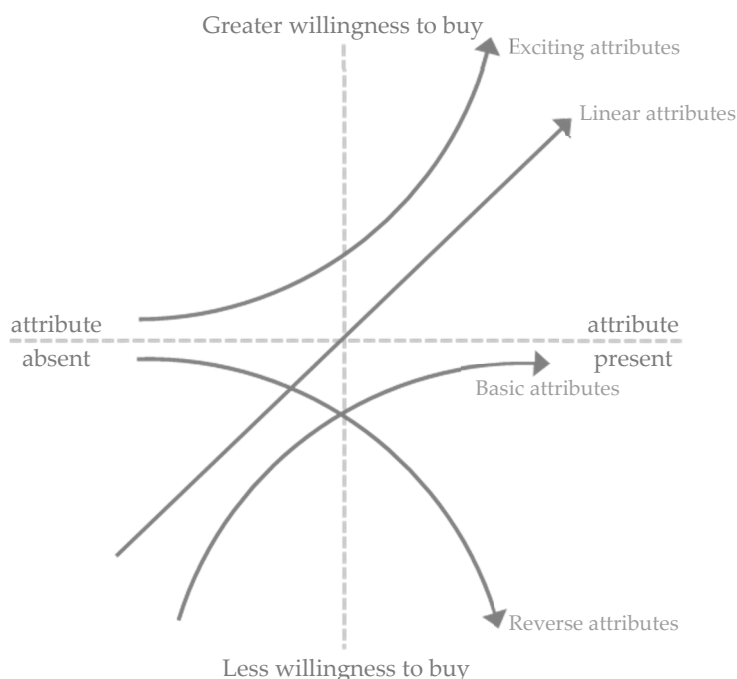


Figure 2. Proposed modification of the Kano model based on survey information collected. Source: Modified from Kano et al. [62], Llinares and Page [67], and Violante and Vezzetti [79].

Since it is possible that attributes such as “thermally comfortable” or “environmentally sensitive” are correlated, a principal component analysis was conducted. In addition to eliminating information redundancy, this procedure enables the identification of latent aspects in the perceptions of respondents. The interpretation of the resulting factorial space, concerning the customer’s willingness to buy the home in question, enables the formation of associations that facilitate the understanding of the results.

Finally, to perform a comprehensive evaluation of the contribution of each Kansei word to the respondents’ willingness to buy, a discrete choice model was applied using logistic regression. In this analysis, the dependent variable is the statement (or not) to purchase the property, while the independent variables represent the different attributes perceived through the Kansei Words. The dependent variable is the result of the dichotomization of the measured intensity of willingness to buy using a Likert scale, as previously mentioned.

3. Results

Figure 3 presents the results of the analysis in terms of the Kano space described above. The “basic” attributes identified, although not significant at 90%, were the attributes associated with thermal comfort and efficient windows. Furthermore, the “linear” attributes (those that increase product attractiveness as attribute presence increases) are related to perceptions of product quality, the value of environmental sensitivity, energy savings, and differentiation capacity. This is undoubtedly relevant, since it portrays the home purchase as a material achievement of buyers’ ideals. This result is not surprising, since these are elements usually used by developers in home advertising [72]. Furthermore, the exciting attributes correspond to a perception of a good investment due to its sustainability features (that is, a long-term, “profitable” product, from the buyer’s perspective), along with the level of common amenities offered (e.g., swimming pools, common rooms, barbecue areas, and terraces). Such elements demonstrate a larger influence on the purchase decision in relation to others. Therefore, it is possible to state that for the cases analyzed the profitability of the investment in housing is more relevant than its sustainable features even when these features may transform the dwelling in a better investment in the long term. Hence, if the sustainable features do not influence the price, the willingness to purchase housing increases, which recalls the phenomenon of “investification” [80]

taking place in the Chilean housing market. This situation implies that the absence of a social security framework related to housing and pensions influences the decisions of consumers about investing in housing projects, that are also a way to produce savings for the future in the form of an asset that provides a long-term fixed capital rent whose valorization in time is seen as granted [81]. Despite this initial analysis, other variables are relevant to understand why energy-related features are not so valorized as profitability.

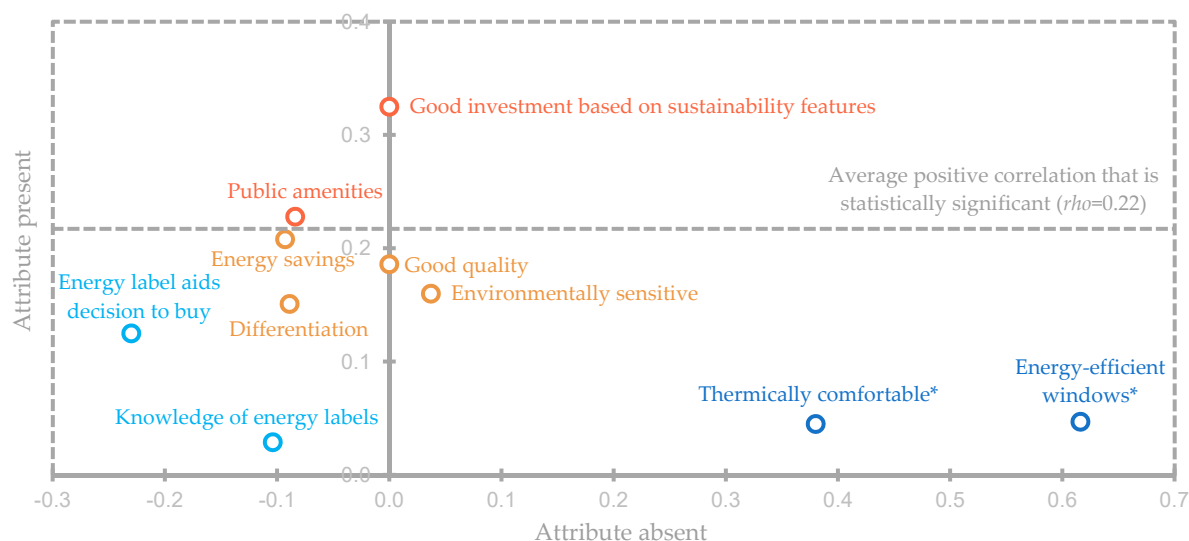


Figure 3. Spearman correlation (ρ) between the survey attributes present and absent concerning the willingness to buy for the definition of the Kano space. Legend (survey attributes): ○ **Exciting**: only when present and above the average positive correlation; ○ **Linear**: only when present and below the average positive correlation; ○ **Basic**: only when absent and positively correlated; ○ **Reversed**: only when absent and negatively correlated; (*) Not statistically significant for $p < 0.09$.

Surprisingly, the attributes associated with energy ratings (that are linked to the score achieved) and the knowledge of the certification scheme turn out to be reverse ones; that is, as their presence increases, the attractiveness of the home decreases. Here, it is possible to offer two preliminary explanations. The first explanation is related to the technical knowledge of the meaning of certification and, therefore, the inability to apply it to the purchase decision. As such, considering that the primary energy efficiency certification in Chile is for household appliances (where more efficiency means higher prices), this implies a systematic ignorance of the true scope of housing certification. That is why a home's energy rating, when perceived as a variable correlated with its price, is recognized as making the home purchase less attractive. Simply put, "since it is better, it must be more expensive, and therefore less attractive to me", as stated verbatim by several respondents during the interview process. A second preliminary explanation is related to the poor perception of certification as a measure of the house's thermal efficiency performance.

To identify further explanations for these reverse attributes, a principal component analysis was performed. Consequently, the nine variables that represent the attributes evaluated, plus two others that represent the cognitive competencies of the respondents (knowledge of energy labels and educational attainment), were considered for the analysis (Table 2). The original variables were consolidated into four principal and uncorrelated components (C1, C2, C3, and C4) as follows:

- C1 is coherent when combining the perception of quality with that of differentiation and the perception of environmentally friendliness with that of a good investment associated with sustainability attributes. Thus, one can say that the demand for these buildings is driven by the following: "if it is a high-quality building, then it differentiates itself from the others, and if it is

also a good investment because of its sustainability features, then a person aware of environment conservation would buy it”.

- The findings for C2 are interesting, since they show a relationship of direct proportionality between the perceived thermal comfort of the building and the fact that the windows influence it. This association is not trivial, since it shows that in the buyer’s imagination, the windows energy efficiency heavily contributes to comfort.
- However, C3 has the most representative findings of our analysis, since it suggests that the level of understanding of the labeling and its contribution to the choice of residence are not applicable to the total demand, but instead concentrated in the most highly educated population. Educational attainment, therefore, represents the key to understanding the energy rating scheme and enables these labels to become a differentiating factor in the residential market. This finding is consistent with a survey applied to users who had been seeking new houses to buy in Santiago (N = 373), where respondents with higher education showed a greater willingness to pay for thermal envelope improvements [51].
- Finally, in C4, a house’s capacity to reduce energy consumption appears associated with the fact that a building is perceived as a good option because of the common amenities offered.

Table 2. Factor loading in a rotated matrix with the results of the principal component analysis ¹ for 11 variables.

	C1	C2	C3	C4
“This is a high-quality building”	0.56	0.06	0.41	0.11
“This building seems to be thermally comfortable”	0.26	0.72	0.13	−0.21
“This building is a good investment because of its sustainability features”	0.59	0.22	−0.03	0.31
“This building stands out from the others”	0.60	0.26	0.07	0.02
“This is a good building because of its public amenities”	0.15	0.10	−0.04	0.72
“People aware of environment conservation would live in this building”	0.72	−0.15	−0.18	0.03
“The energy efficiency label is a good aide in making a buying decision”	0.21	−0.11	0.72	−0.19
“This building enables savings on electricity and gas bills”	0.08	−0.06	0.04	0.69
“This building has windows that reduce energy consumption”	0.06	0.85	−0.04	−0.09
Knowledge of energy labels	−0.14	0.09	0.52	0.37
Education level	−0.21	0.42	0.53	0.02
Eigenvalues	2.35	1.45	1.10	1.07
Percentage variance	21.3%	13.2%	10.0%	9.8%

Correlations greater than 0.5, considered to be significant according to sampling criteria [82]. ¹ Method of rotation: Varimax with Kaiser normalization. Components with eigenvalues <1.0 were deleted from the final solution according to Kaiser’s criteria. The values in the diagonal of the anti-image correlation matrix and the communalities are all over 0.5, which confirms that each variable shares at least half of the variance with other variables.

Another complementary reading is one that compares the opposite associations (i.e., inverse correlations) between each of the original variables and the four principal components, even if they are not significant. For example, as mentioned above, the original variable “environmentally sensitive” is associated with C1 but inversely correlated with C2 for the perception of comfort and with C3 for the usefulness of energy labels. This reiterates the lack of understanding of what energy efficiency represents, since an energy-efficient house should be environmentally sensitive while ensuring adequate thermal comfort.

The same inconsistency is seen in the original variable of “energy label as an aide in the purchase decision”, that is inversely correlated with C2 (perceived comfort) and, above all, inversely correlated with C4 (energy savings perception). This confirms the incorrect relationship between the role of the energy label and the energy savings, as indicated in the preliminary explanation above. Likewise, the original variable of energy conservation associated with C4 is inversely correlated with C2 for perceived comfort, which suggests that people believe that lower energy bills are achieved at the expense of indoor comfort, also confirming the previous hypotheses. This relationship is very relevant, since it reveals the energy rating’s significant inability to support a consumer’s purchase decision. Similarly, it is interesting to note that educational attainment, which is associated to C3 (correct understanding of energy labels), is inversely correlated with C1 (subjective perceptions), underscoring that rational and emotional perceptions do not necessarily align in the same direction. Even more impressive is the fact that this association with more rational perceptions has a correlation associated with educational level and highly probably also with socioeconomic status, given the country’s income distribution inequality and its social implications [83].

Finally, Table 3 details the influence of each evaluated attribute on the stated probability of purchase, using the proposed discrete choice model. Table 4 presents the adjusted model, which shows that despite the simple structure of the statistically significant variables, the model’s fit is 75.8%. It is especially noteworthy that the significant variables pertain to C1 and still do not present significant collinearity problems. In short, the good investment perception resulting from sustainability features, the building’s differentiation from others similar to it, and the object-subject association in relation to sustainable habits are the variables that increase the probability of buying over the likelihood of not buying by factors of 3, 2, and 1.5, respectively. The fact that the perceived energy consumption savings are not correlated with the willingness to buy is very significant, suggesting that policy to promote energy-efficient buildings that incorporate psychological rewards in addition to financial ones could be successful. This does not rule out the rational approach to the real estate purchasing decision, since some of this approach comes from understanding how sustainability is associated with a “good investment”. However, it incorporates other variables that are more emotional than rational and that have associations with energy efficiency that are generally not considered either by real estate developers or by public policy [72,84]. In this sense, the disregard for thermal perceived comfort indicates the need to work toward linking the attributes of sustainability with their impacts on this emotional vector, since they currently appear disconnected.

Table 3. Odds ratio of the independent variables included in the logistic regression and the dependent variable of willingness to buy.

	Odds Ratio ¹	Sig.
“This building is a good investment because of its sustainability features”	3.17	0.009
“This building stands out from the others”	1.96	0.023
“People aware of environment conservation would live in this building”	1.49	0.022

¹ The odds ratio can be understood as the number of times the probability of occurrence $P(Y = 1)$ increases when the independent variable increases by one unit.

Table 4. Odds ratio of the independent variables included in the logistic regression and the dependent variable of willingness to buy.

Observed	Predicted			
	Willingness to Buy		Percentage Correct	
	0	1		
Willingness to buy	0	52	17	75.4%
	1	13	42	76.4%
Overall				75.8%

4. Discussion

This research is aimed at determining whether there is a contradiction between the sustainability of housing projects and its profitability as an investment from the perspective of consumers. To address this question, the paper assessed the contribution of energy efficiency labels to either the decision to purchase a real estate product or the attractiveness of the product. By applying a hybrid Kano and Kansei Engineering methodology to three case studies in Santiago de Chile, it was first determined that thermal comfort and energy labeling attributes are in different location positions of the identified Kano space. While the former is basic (and statistically insignificant), the labeling attributes are inverted; that is, they appear as unfavorable in a purchase decision. Moreover, the principal component analysis further explains this situation, which can be succinctly described as a disconnection both in the perception of what is being measured in the labeling and the contribution of these labels to the choice at hand.

In this sense, it could be said that the information provided by the label (as it is today) cannot bridge the information gap identified by Allcott and Taubinsky [85], since the energy certification scheme does not help consumers to estimate energy savings adequately and does not provide easy-to-understand cognitive resources that contribute to an adequate representation of the real value of energy efficiency. This argument is consistent with other studies [55,86,87], which establish that the relative importance of energy efficiency in the purchase decision significantly increases when it provides easy-to-understand energy savings information, even over traditionally highlighted attributes. This discussion confirms two observations that can be made from the results of this article: (1) the main criterion to decide to purchase housing is the profitability of the project in relation to its characterization as a good investment based on sustainability features; (2) more transparency and simplicity in the content of energy labeling would facilitate its understanding as a tool to support the real estate purchase decision; and (3) if this is done, the energy rating scheme can effectively collaborate in bridging information asymmetries between sellers and buyers, triggering buyer interest in energy-efficient homes.

However, even though this gap between understanding energy labeling and its value can be theoretically resolved, the problem of the insufficient coverage under the current voluntary scheme persists. Moving toward a mandatory system after five years of an optional system seems to be the natural next step, since the European Community's evaluation of its EPC model suggests that it is the only way to impact the massive housing market effectively [46,88]. The case of South Korea is interesting in that, like Chile, it has a voluntary energy rating scheme since 2013. In this case, the evidence also suggests moving from the current voluntary system to a mandatory scheme [6].

In this sense, the proposed Energy Efficiency Law to make energy certification mandatory seems to be a step in the right direction, an opinion that the authors expressed in the parliamentary debate on the proposed law. However, several aspects must be considered in discussing the implementation of this type of mandatory scheme. The first aspect to bear in mind is that adopting an EPC-style model when there has been meager voluntary participation will lead to a significant gap between implementation and obtaining verifiable success, given the need to develop a market around the energy efficiency of homes. Next, it is crucial to understand that systems based on providing information to consumers cannot fully capitalize on energy efficiency in the real estate market, since their role is to support and amplify the effects of other public policies, such as regulations or financial incentives. For example, although information asymmetry is often used to justify energy efficiency policies, it should be complemented with instruments such as subsidies [85]. This can be explained by the fact that information asymmetry is just one of the many market failures that can arise around the energy efficiency of homes. As noted by different authors [52,57,89,90], mandatory labeling is a critical step, but to take advantage of its full potential for information and communication, it must be combined with instruments such as tax incentives and strategic subsidies to avoid producing a "brown discount" among populations with the lowest income—as found by McCord et al. [91]—and to increase the possibility of attracting private capital using a "green finances" mechanism to foster energy-efficient buildings.

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