

Southern Orientation and Natural Cross Ventilation: Mind the Gap(s) What Clients, Valuers, Realtors and Architects Believe

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Abstract

Sun, Air and Water are the most powerful sources of life on earth. Southern Orientation (SO) and Natural Cross Ventilation (NCV) are the best expressions of our relationship to those eternal forces. SO and NCV are behind any successful Passive Solar Design. Health, comfort, air quality, natural lighting, residential satisfaction, good micro-climatic conditions, green spaces, vegetation, energy-saving, and psychological well-being rely on these two archetypal determinants. Architectural practice is constantly accentuating the fact that our homes and cities need solar access and ventilation. Research in the Health and environmental sector reveals an urgent need for SO and NCV. Research from the real estate field is segmented and not conclusive on these values. People are buying apartments overlooking the importance of SO and NCV. Developers are building in a bulk manner, unaware of any benefits. Realtors are underestimating these qualities. Most importantly, valuers estimate all other factors, except these two. There is confusion on what has a real value for our life and to what extent this can be measured and quantified. Survey-based economic techniques will have to be employed for the valuation of SO and NCV as for now, according to research, they do not seem to have a market value (or price). We might have to rely more on “stated preference” models, in contrast to a price-based “revealed preference” model. The contribution of this work is intended to be the trigger to all, for attention on SO and NCV as archetypal determinants of value.

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1. Main Text

1.1 Introduction and scope of research

In traditional valuation methods, some main factors are influencing value appraisals. These include structural variables, accessibility variables, neighborhood variables and environmental variables (Xixia, 2006). However, there is empirical evidence that other factors (i.e. orientation, plan layout, natural lighting, cross ventilation, materials and components quality, suggested lifestyle) are usually neglected by the valuers during the process of valuation. There is a hidden quality and stability in those factors (so called “Design Parameters”) that can totally change the perception of a property when it is under examination. Most valuers are not architects and there is a big chance they cannot identify crucial design differences between two identical properties when estimating their market value. Most of these “neglected” factors are influencing health and comfort of the tenants in housing units. Unfortunately, there are very few studies on the value of those building parameters. (Chan et al., 2008). This study is focusing on residential apartment units as a very important sector in valuations that presents more uniform or “stable” characteristics than commercial properties. Unlike detached houses, the physical layout in apartment units can hardly be changed. Potential buyers rationally anticipate that and therefore would likely “price in” the effect of the design parameters. In addition, apartment units are easy to compare. Thus, apartment units may provide a natural setting for the study of the price effect of physical layout. (Leung, Ma and Zhang, 2014). In addition, the focus of this research is limited to the two most important factors between the Design Parameters:

Southern Orientation (SO) and Natural Cross Ventilation (NCV). Many reasons dictate this choice: a. The idea that the sun and the wind are the most prevalent natural forces that affect the design (or should affect it, as it is stated later). b. The notion that these two are the most important features of what is called “green design”, which is evaluated in terms of energy savings and as an added value in some research papers. c. The fact that there is not sufficient research on these two particular subjects and d. The observation that, clients and valuers have difficulties to identify the hidden qualities of such factors, where are responsible for comfort, health and well-being of the occupants of apartments.

1.2. Literature Review

Few researchers examined the impact of design quality and architectural characteristics on the market value of residential projects (Smyth, 1994; Ta Son, 2005; Kioussi, et al., 2010). The difficulty in defining “design quality”, as it usually relies on subjective perception, while counting not only on direct factors be involved to impact the market value, such as political climate and the culture aspects to add sophistication for inquiring design aspects in relation to the market value of residential projects. (Nachar, 2011). During this review, an extensive presentation of existing research (i.e. statistical, empirical) is included, in order to form a holistic approach with a complete spectrum of determinants / factors strongly related to the valuation process. Observations on the clients’ willingness to pay for such features also examined to highlight possible trends and pre-occupations. With a better understanding of how people’s demands vary, developers can invest in projects and identify target customers more efficiently; architects can create better floor plan designs; and real estate agencies can provide more individualized services. For example, “south facing” was one critical mean of evaluation of the floor plans of medium sized apartments in Beijing (Gao, Asami, Zhou, Ishikawa, 2013). One important aspect of this research to be emphasized is the creation of awareness to valuers on these issues, when examining a property and the possible shift of Market’s perception on what other factors should count when evaluating an apartment unit. In a study (Leung et al., 2014), authors argue that “While the internal design of housing units is usually perceived to be influential on house valuation by ordinary people as well as real estate brokers, it is typically “absent” from the hedonic pricing model, and thus economists have little information about its quantitative importance. In fact, practitioners are also aware that there is a lack of research on the price impact of design, as reflected in the quotations above. There seems to be a “missing link” between “conventional wisdom” and the academic literature”. An interesting extract from this study is that the authors value that: “Last but not least, more cross-disciplinary research between real estate and architecture may prove to be mutually beneficial. We believe that research along these lines would eventually provide academic value as well as practical implications for property developers and architectural firms.” We have to add to this remark that valuers can also collaborate with both disciplines by leading the Market to a better understanding of critical factors that should affect market values, since they are definitely affecting peoples’ lives. However, this is arguable as to up to what point valuers can be expected to affect the Markets (Smolen & Hambleton, 1997). Research on the impact of “Green Architecture” or other Architectural features in housing and apartment values, or the clients’ preferences on “green” has been done. (e.g. Boyle & Kiel, 2001; Fuerst & McAllister, 2009; Leaman & Bordass, 2007). Different terms are used all around the world to underline benefits of buildings with potential of energy saving. Terms like energy efficiency, green value or sustainability are the most commonly used. Several methodologies have been explored in order to measure in the best possible ways the “green” impact. By Implementing data from Energy Performance Certificates (EPC) into real estate assessment (Popescu et al., 2009), to the most intricate ones that rely on econometric analysis of data, hedonic models and more advanced techniques (i.e. neural networks). One trend nowadays is the use of large Databases in an attempt to have better accuracy, due to the huge numbers of the examined subjects. A study (Miller et al., 2007) compares data on Energy Star and LEED-certified buildings (Leadership in Energy and Environmental Design) versus non-Energy Star or non-LEED-certified office property from the entire United States using the CoStar database. McGraw-Hill Construction’s report for 2008 presents another real estate market analysis of green value in U.S. It points out that during 2007, commercial Energy Star

rated buildings were sold for approximately 15% higher prices, had 8% more in rental income, and saved 10-20% in operating expenses (Murray, 2008). Others performed mass appraisals based on energy labels (Bonifaci, P., Copiello, S., 2015), where concluded that sale prices are positively associated with building's orientation. Other studies have also analyzed the effect of architectural design features on the price of buildings. (e.g. Pawlicka, 2014). Architecture and design related features are not easy to quantify with a measurable variable and therefore are generally not being considered during appraisals and in hedonic pricing models of homes (Plaut, S., & Uzulena, E., 2005). Research shows that most of the time, there is relationship between green features and price, although this relationship is not always predictable. There is evidence that architectural design can be effective on the price. However, there is no research studying the relationship of specific sustainable architecture features such as orientation or elongation on the price. (Fadaei et al., 2015a). In an article titled: *"Architecture: A missing piece in real-estate studies of sustainable houses"*, the reality of a missing element, a gap, in real estate studies is addressed (Fadaei et al., 2015b).

Architectural literature strongly suggests SO and NCV as important values. A clear understanding of sunlight's value is emerging. Orientation is a critical component of energy efficiency and the ability of a building to properly mediate the summer and winter sun heat loads which penetrate through a building (Xixia, 2006). Solar access in cities regained attention in the western world during the urbanization of the nineteenth and early twentieth century, where health was the one and only motivation. In his 1893 book *"Healthy Hospitals"*, Douglas Galton wrote: *"Second only to air, is light and sunshine essential for growth and for health; and it is of Nature's most powerful assistants in enabling the body to throw off those conditions which we call disease"*. An essential book titled: *"The Orientation of Buildings, or Planning for Sunlight"* was written in 1912 by William Atkinson. Architects are dealing for long with the evaluation of the sun and the assessment of its benefits. The natural world appears to abound with examples of arrangements based on exposure to the sun. The idea of solar access is ancient. It was practiced in early settlements (e.g. Acoma Pueblo), in Greek Cities as Olynthus (Fig.1a, 1b) or Priene (Fig. 2a) and in new neighborhoods like Eixample, Barcelona (Fig.2b, next page).

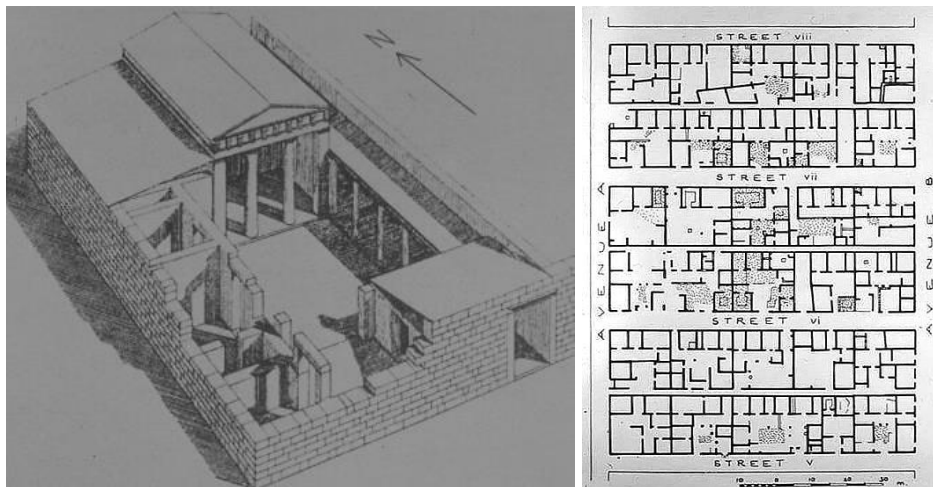


Fig. 1 a,b: House and Plan of Olynthus. The streets were built perpendicular to each other, running long in the east-west direction (the horizontal streets shown in the plan), so that all houses (five on each side of the street) could be built with southern exposure. In keeping with the democratic ethos of the period, the height of buildings was strictly limited so that each courtyard received an equal amount of sunshine.

Our cities today are non-directional. Our buildings are undifferentiated by orientation to the sun (Knowles, 1974, 1980, 1981). Professor Knowles developed and refined a method that strikes an optimal balance between population density and solar access: the "Solar Envelope" (Fig.3, next page). It is a set of imaginary boundaries,

enclosing a building site, that regulate development in relation to the sun's motion — which is predictable throughout the seasons for any place on Earth. Buildings within this imaginary container do not overshadow neighboring buildings during critical energy-receiving periods of the day and the season, and assure solar access for both passive and active solar systems. The above example is a characteristic one, showing where architectural research on the matter on south orientation has gone until today. A question arises: If South Orientation is such a serious matter for habitation in apartments in cities, for centuries, why today it is not even mentioned in valuations?



Fig. 2 a,b: Priene Representation Plan c.350 B.C, Eixample, Barcelona by Cerdà, c. 1850



Fig. 3: Buildings within the solar envelopes. Ralph Knowles

Ventilation rate could influence performance indirectly through its impact on infectious diseases, prevalence of sick building syndrome (SBS) symptoms or dissatisfaction with air quality. Relatively few studies report the effect of ventilation rate on objectively measured performance. Effects of ventilation rates have been long recognized. An

increase of ventilation rate usually results in better perceived air quality and a lower concentration of indoor generated pollutants. Low ventilation rates generally lead to higher prevalence of adverse health effects, including SBS symptoms and air borne infectious diseases (e.g. Seppänen et al., 1999; Seppänen and Fisk, 2002; Li et al., 2007). Other studies have been trying to estimate the relationship between ventilation rate and absence from work (i.e. Fisk et al., 2003) or health and productivity gains from better indoor environments (Fisk, 2002). One of the most important parameters in order to achieve a quality indoor climate, as research determines, is definitely Natural Cross Ventilation (NCV) (Seppänen et al., 2003). In Architecture, from the ancient times, Natural Ventilation was always in the battle for comfort. The vernacular architecture introduced many realistic solutions and devices to the local environmental problems such as the Wind-catcher (Fig.4), which became a common architectural feature in buildings. In recent decades, there has been an increasing awareness of these traditional environmental devices and their potential for possible future buildings (El-Shorbagy, 2010).



Fig. 4: Badgirs (Wind-catchers) in Iran

1.3. Stated Willingness To Pay (WTP)

The current green development requires that residents' expectations and preferences are taken into account (White and Gatersleben, 2011). Residents' preferences can be measured by their Willingness To Pay (WTP) for attributes that offer added value to their property. The assessment of influence of clients on valuations (e.g. Schuck & Levy, 2005), or on how to measure WTP (e.g. Miller et al., 2011) or on methods for collecting information by considering consumers' preferences (e.g. Nakata, 2007), have been studied extensively. Besides cost saving, some research finds that green building buyers place premium value on better health conditions (Guo et al., 2010). Although "green" dwelling attributes are found to be important, the relative weight of them in making a housing purchase has not been systematically analyzed (Hu, H., Geertman, S., Hooimeijer, P., 2014). Other studies (e.g. Mandell, S. & Wilhelmsson, M., 2011), conclude that *"It is not obvious that environmental attributes should be associated with a positive willingness to pay"* or *"it is an interesting finding that households that state that they perceive themselves as environmentally aware actually show a significantly higher willingness to pay for environmental housing attributes."* C.K.Chau, M.S.Tse, K.Y.Chung (2010) are arguing that very few studies have been attempted to explore end-user behaviors towards green building development. Agnieszka Zalejska-Jonsson (2014) aimed to study stated and rational willingness to pay for green apartments in Sweden. It was found that interest in and the perceived importance of energy and environmental factors affect the stated WTP. The results indicated that a stated willingness to pay for low-energy buildings of 5% can be considered a rational investment decision. Nikolaos Zografakis et al. (2009) analyzed and evaluated the citizens' public acceptance and willingness to pay (WTP), for Renewable Energy Sources (RES) in Crete. For this purpose a contingent valuation study was conducted, using a double bound dichotomous choice format to elicit people's WTP and factors affecting it. Larger willingness to pay was reported by those with high family income and residence size, those having a higher level of energy information and awareness concerning climatic change, those who have invested in some energy saving measures, and those who suffer from more electricity shortages than others. The latter research is used here to present evidence on the perception of the people on the necessity of Renewable Energy Sources. It is relevant to this work, because it accentuates the categories of people that are willing to pay, according to their awareness, not only for their house amenities, but also for a public good, beneficial to all.

1.4. Research Methodology

Own research included: 1. Research through text mining in a Dataset of market advertisements for 428 apartments retrieved from realtors in Barcelona, Spain 2. A questionnaire made for valuers in order to identify their priorities when evaluating (see also Appendix B) 3. A poll made through a social media platform (Facebook) where a simple question was proposed to the respondents, in order to measure the spontaneous response on the matter of Willingness To Pay (WTP) for Southern Orientation and Natural Cross Ventilation and 4. A limited regression analysis on reliable data found for 34 apartments in Cyprus. From each of the above, conclusions were drawn and are briefly presented in Appendix A

1.5. Findings and Conclusive Comments

In real estate literature the matter of association of value with all possible characteristics of a property has been employed many researchers. Almost all studies try to find ways of measuring every aspect of any property, having a certain scope: to acquire adequate knowledge of what are the effects of each parameter in order to define better valuations or future predictions for development in this area of interest. This research although it is vast, it seems segmented and that is reasonable due to the complicated network of determinants and differences in peoples' perceptions for value or because of different social, demographical or legal characteristics in every place in the world. There seems to be a "missing link" between "conventional wisdom" and the academic literature." (Leung et al., 2014). Findings on the willingness to pay are controversial and do not present any uniformity, due to

their segmented nature, where each case is different. For example, rich or educated people are willing to pay more for architectural or sustainability attributes in countries like Switzerland (Banfi et al., 2006) or Sweden as some studies imply (e.g. Jonsson, 2014) when compared to the people in China that are willing to pay a premium only for energy conservation, but not for water conservation, air quality improvement or other green amenities (Chau et al., 2010). The above findings might have a relation to the awareness of people on what is valuable to them and their respective ignorance on many green features, or on how things work generally. However, this field of research (on WTP) is found that has a very important benefit: It uses results from data coming from the people by exploiting different kinds of questionnaires, interviews or experiments recording real preferences on a range of issues, somehow trying to close the gap between academia and reality. Exploring research on the evaluation of intangibles can lead to an even larger set of parameters and can be chaotic. Research in environmental psychology detects once more the differences between perceptions of the people. On the matter of Residential Satisfaction (RS), psychologists argue that not recognizing RS in designing projects leads to severe problems. Consequently, it influences the quality of life and affects the psychosocial aspects of the inhabitants (Mohit et al., 2010). Studies of people satisfaction with their residential environment have showed complex patterns of relationship. It is found from research that despite the fact that RS is a very important subject for many professions however there are different interpretations of RS. In fact, the emphasis of architects is more on dwelling physical features and housing status whereas other professionals take into considerations other social and commercial aspects (Mehdi et al., 2012).

Own research found that –as it is indicated by the results– the majority of people are not aware of the importance of SO and NCV. Valuers are found to pay no or little attention to that matter following a preconceived way of thinking. This, although the sample was small showed a possibility of some degree of ignorance regarding these features. Realtors do not evaluate such characteristics as important enough for being exploited in marketing. There is a possibility that the sample (Barcelona) did not have a substantial amount of SO or NCV, due to density or closeness of the properties, but still findings were unacceptably low. However, if that was the case, then there is a comment that can be said for the quality of life in today's cities, especially within individual properties. The hypothetical buyers were also not very aware of the significance of SO and NCV. Both simple tests (in Social Media and the Brief Regression) showed a very slight –not significant– preference to SO, that cannot by all means be considered as measurable. NCV was not evaluated respectively, if not at all. Only the architects respondents gave important premiums on both, presumably due to their better knowledge on these issues. Although the samples were not enough for a coherent analysis, found a trend that can lead to some conclusions on the perception and knowledge of different groups of people. This trend of “non-awareness” is supported by the extensive literature, where we cannot find any evidences of research stating that anyone would pay a premium of more than 5% for related features (and not SO or NCV), no matter how rich, well-educated or environmentally friendly he/she is.

There is a gap between what the past teaches, what architects believe and to what is valued from the public. People are buying apartments in the cities overlooking the importance of SO and NCV. Developers are building in a bulk manner, unaware of any benefits. Realtors are also unaware of these qualities. Most importantly, valuers estimate all other factors, except these two. There is confusion on perceptions of what is good, what has or hasn't a value for our life and to what extend this can be measured and quantified. There is no valuation method for detecting the value of SO and NCV. The reason for that gap is likely a difference in perceptions and ignorance on that matter. One can question why there should be a difference in perception on such obvious advantages. Monetary property value is not the only type of value that should be considered when evaluating SO and NCV. Other types of value such as the ones mentioned before plus the decreased operating costs, cost losses and marketing advantages, add an implicit form of value, suitable for a money-driven societal structure. It seems urgent to suggest to the bodies of researchers to study that matter in a more intense, cohesive manner and through a holistic approach.

1.6. Suggestions – Future Research

Valuation of SO and NCV needs knowledge and inter-disciplinary collaboration. It needs awareness from the people in all related fields of the “industry” of properties. The world is becoming increasingly more urbanized. By the year 2050, almost 80% of the people in the World will be living in cities, packed in low-quality apartments, meaning with density and lack of solar access or proper ventilation. Many people are discouraged by the complexity of green features and the terminology. If consumers do not know, or underestimate what SO or NCV is, how it will benefit them and the cost tradeoff, they will never buy a building that benefits from these features. Educating buyers on the reduced operating costs and increased health & comfort associated with green buildings will cause demand for more green features in their buildings. Researchers will have to focus more on SO and NCV as prominent characteristics of good design for apartments and apartment buildings as a whole. They have to analyze and find the positive trends using a holistic approach on the subject, than a segmented and complicated one. This paralysis caused by the plethora of available and very specific information on over-specialized areas of interest is resulting to very weak and non-uniform results. That does not allow for an international guidance on what are the real values that could affect the price of properties. Researchers have to somehow educate the rest of the relevant professions in order to have this brake. Developers, Policy makers, Valuers, Realtors could acquire some knowledge on this very important issue, thus they will have a direction on what to expect for a well-designed property. “It is not rocket science” as we say. It is only a matter of understanding how nature works. It is not even more expensive to account for Sun and Air, for SO and NCV in particular. It only needs a conscious and careful design. It does not affect cost at all, but the added value is immense. This “gap” between academic approaches and reality and the gaps between peoples’ perceptions can be bridged by the simple reference on two unquestionable values. It is the responsibility of the “educated” to eliminate ignorance and to increase public awareness. When people understand how basic these values are, will have a demand for these that can be quantifiable. Education even from pre-school is suggested on all architectural issues that affect life quality. Clarifications are needed in used terminology. This not an easy task, it goes against peoples’ preconceptions, fears and every day worries. It has to be pointed out that only by living in environments that favor SO and NCV their quality can be justified.

The findings trigger some important implications. Future research can find some interesting results using a closer-to-people (and reality) research methodology. To be specific, a holistic approach to the valuation will probably lead to some alterations in traditional valuation methods. A certain way of evaluating SO and NCV has still to be found. Any analysis that can use the advantages of contingent analysis will be benefited. A simulation analysis that employs qualitative assumptions associated with these archetypal determinants (SO and NCV), will weave different scenarios and will obtain the most optimal responses. Survey-based economic techniques will have to be employed for the valuation of SO and NCV as for now they do not seem to have a market value (or price). We might have to rely more on stated preference models, in contrast to a price-based “revealed preference” model (e.g. Timmermans et al., 1994). When “big data” and large data sets are employed in hedonic models are lacking of any detailed information and do not, by all means, record the stated preferences. Contingent Valuation surveys can assess such values of existence. Contingent valuation refers to directly asking individuals how much they would be willing to pay for “greenness” in buildings. This highly-stylized survey setting allows researchers to eliminate many of the factors that complicate consumer decisions in real-world settings. (Zhang, L., et al., 2017). One other kind of analysis through the use of big data could be Sentiment analysis that can explore the public trends and awareness for the subject through text mining. Public awareness is also another task to be tackled. By preparing educational tools on this matter for different categories of professionals and the public and by doing this in a holistic and inter-disciplinary manner, will be beneficial for Valuation of SO and NCV. Indeed, a lot of work has to be done, hopefully by all related.

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Appendix A.

Own Research Results

A1. Research through text mining in a Dataset of market advertisements for 428 apartments retrieved from realtors in Barcelona, Spain. Each advertisement included a short description of the apartment, as well as its important characteristics that might interest the possible buyers. The texts from all the 428 advertisements were collected to one single text. Our purpose was to find the most relevant words to our research topic. Thus, the words "Orientation", "South", "Sunny", "Southern", "Solar", "Sun", "Sunlight", "Light", "Daylight", "Bright", "Luminous", "Ventilation", "Cross", "Airy", "Natural" that are relevant and expected to be used, where the first ones mined from the texts. The most frequent words did not include any of the above. Specifically: The word "Orientation" appears only 8 times in the texts, "Lighting" 8 times, "Luminous" 7 times, "Sun" 11 times, "South", 11 times. On the other hand, the word "Sunny" appears 22 times, "Natural" 47 times, "Bright" 54 times, "facing" 27 times. This latter set of words, though have an ambiguous meaning and do not describe exactly the physical attributes of the property and by no means are frequent too. It seems that realtors are not evaluating such characteristics as between the most important or just of medium importance of all possible attributes, when they write texts to promote their properties.

A2. Questionnaire to the Valuers (see also Appendix B). This was structured on a simple line of questions and was based on two hypothetical apartment buildings. It was then consisted of two parts: Project A and Project B. For both of them a typical floor plan drawing was given. The drawings were made in such layouts and the north sign was given too, in order to let the valuers to decide, based on their perception from the drawings and all given information. A total of 17 respondents took the time to fill all the prices asked. All answers were collected on a spreadsheet and some calculations were made. For each set of data, regarding each apartment, an average was calculated and also an average of the price estimation per square meter. Thus, the comparison was easier to make. By having to compare the average price estimation per sq. meter for apartments on the same floor we eliminate the determinant Floor, which plays an important role in estimations. On the other hand, in Project A, where we have different areas for apartments, we eliminate the determinant Area, by having an average per sq. m. However, some of the respondents seemed to have some prejudices, or a strong mindset on values, driven from other reasons (i.e. some estimate the same value for 1st and 2nd floors and only raise it on 3rd and 4th). Some also stated that the size of 95 sq. m. is more saleable than the one of 130 sq. m., presumably because of their experience in the Greek or Cypriot markets, so they gave higher prices per sq. m. for the smaller apartment, due to its saleable size. As for the determinants they take into consideration when they are estimating (Question 3 in the Questionnaire), their answers were (as written by them): Location, IPMS, Materials (if different), View, Age, Quality of Construction, Floor of each apartment, Comparative sales, Position in the Floor (e.g. corner unit), Size of Flat, Dual-Aspect Unit, Road relation (back/front apartment), Renovated or not, Proximity to green area, Parking/storage facilities of apartment, Building Design, Neighborhood, Maintenance cost, Developer's name, Management of property, Front, Back, Number of Floor, Internal areas. Only 2 out of 17 mentioned the word "Orientation". No one mentioned the word "Ventilation", except one that said that he took into consideration the Dual Aspect feature of the property (meaning two Facades to the street, probably), that may imply ventilation probability, or just that the apartment is a corner unit. From the above research, a conclusion is extracted, that, this small (but respectable) sample of valuers did not evaluate any of the two examined characteristics (SO, NCV). However, we have to mention this one case of a valuer that sent a very detailed spreadsheet with all adjustments, who evaluated these two factors, namely Orientation and Dual Aspect property (as he described the NCV favorite apartment). He gave an estimation that accounts for a 5% premium for each one of the two examined factors.

A3. A Poll was conducted in a Social Media platform (Facebook) where the purpose was to record the spontaneous answers of future home buyers and investigate their willingness to pay some extra amount for the examined two apartments' characteristics (SO, NCV). A simple question made, accompanied by a plan sketch of three apartments, in order to make the question more comprehensible. The Question was: *"There are 3 Apartments (D1, D2, D3) in the same apartment building, in the same neighborhood (somewhere in Greece) on the 3rd floor. These have exactly the same attributes: The same Views, the streets around, the same quality construction, quality design, the same length of facades, all amenities are exactly the same! The differences are: Apartment D1 has a living area to the North and it is not easy to naturally ventilate it. Apartment D2 has a living area to the South and*

it is not easy to naturally ventilate it. Apartment D3 has a living area to the South and it is very easy to naturally ventilate it. If Apartment D1 is currently sold 200,000 euro, which is the amount you would like to pay for the other two Apartments (D2 & D3)? Compare each of the 2 separately with Apartment D1. This is a survey I do, part of which deals with the intention of apartment buyers (clients' willingness to pay). Answer to me with 2 prices for the 2 Apartments (D2 & D3)". A total of 75 respondents answered. 59% (44/75) were women. Ages were between 22 and 65, evenly distributed. 56% (42/70) were architects or (very few) in related professions (civil or mechanical engineers). 89% (67/72) were living in Greek cities and 11% in Cyprus. Some (3) outliers were excluded from the sample, due to their superficial answers. The results showed a certain preference for the two attributes (SO, NCV) and the peoples' willingness to pay an extra amount for the apartments which had SO and/or NCV. From the total of the 75 respondents, it came out that for Apartment D2 the average amount people were willing to pay is 214.346 (a premium of 7.17%) and for apartment D3 the average was respectively 217.504 (a premium of 8.75%). The above is more rationalized when we explored the answers given by the architects and by non-architects. The architects would pay for D2 an average of 219.726 (a premium of 9.86%) and the non-architects would pay 207.480 (a premium of 3.75%). For D3 the architects would pay an average of 225.738 (a premium of 12.87%) and the non-architects would pay for D3 an average of 207.130 (a premium of 3.56%). That categorization was necessary, in order to understand the sources of the initial total percentages. From the above average premiums are indicating that due to their professional knowledge, architects are tending to evaluate more these parameters (SO, NCV) and they know more about the benefits of the examined determinants, than other professionals. In fact, the non-architects had a "strange" perception for apartment D3, because they gave a smaller average than of the one for apartment D2, although it has a double advantage. People answered spontaneously and some preconceptions have occurred, due to the nature of the media platform where everybody wants to comment too. The comments exhibited an association between Natural Cross Ventilation (NCV) and unpleasant feelings of wind blowing in the house, or that this means energy losses, or they made some assumptions totally irrelevant to the question, never implied by it.

A4. Another sample of 34 apartments from Cyprus was collected in order to evaluate, if possible, the market trends, by any means of significance that relates SO and NCV to the price of apartments. The sample was relatively homogeneous. The apartments were made by the same developer, in similar areas of Nicosia, Cyprus. All apartments had the same (medium) quality of construction, and almost the same exterior affecting factors. From the interview conducted with the developer it was possible to get the following information: The Price, the area, the floor number and the month/year in which, each apartment was sold, the plans indicating the orientation. The floor area of apartments ranged from 49 sq. m. to 136 sq. m. The average area is 83 sq. m. The adjusted prices ranged from 94.400 to 329.000 euros. Adjusted prices per sq. m. ranged from 1.903 to 2.444 euros. In order to investigate further potential associations between the Orientation, Ventilation and Floor (independent variables), with the Adjusted Price per Sq. M. (dependent variable), linear (each one of the independent with the dependent) as well as nonlinear, multivariate, stepwise regression analyses were implemented. The regression was stepwise, so as to keep into the model only the statistically significant variables. The selection criterion was the p-value for the continuous variables while for the categorical the chi-squared test, with a threshold of 5% for both cases. The nonlinear model, examined squared, cubic, quadric, logarithmic, exponential and sigmoid functions of the independent variables as predictors. The continuous variables were normalized in the domain between zero and unit [0, 1] so as to avoid numerical instabilities as well as to be able to compare the regression weights as importance measurements of the independent variables to the response. The r-squared for the stepwise regression was sufficient (0.93215), however only the area found to be statistically significant.

Appendix B. (Questionnaire for the Valuers)

Dear Valuer,

I would really appreciate if you spend some time to fill this questionnaire regarding research work I am currently doing. In fact, this questionnaire is comprised by a base plan of an apartment building and you are asked to estimate the values of apartments respectively, according to the given data and a base price.

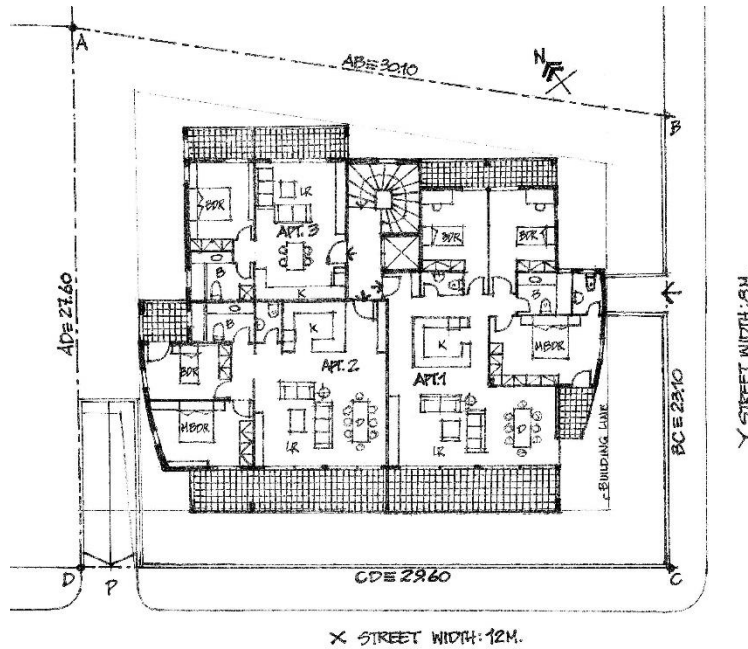
Project A: The apartment building is hypothetical. The site has an area of 750 m² and the Building Factor is 160%. The total area of the heated spaces, including the common space is 1.200 m² (300 m² x 4 floors). It is a 5-storey building. On the Ground floor there are no apartments, only parking spaces and storage spaces for all apartments. Apartments are identical in each plan on floors 1-4. Each of the identical floors contains the following typical apartments:

Apt 1: 3-Bedroom, Kitchen, 2 baths, 130 m², covered verandas: 26 m² (front corner of the lot)

Apt 2: 2-Bedroom, Kitchen, bath, 95 m², covered verandas: 22 m², (looking to the main X street).

Apt 3: 1-Bedroom, Kitchen, bath, 55 m², covered verandas: 12 m², (looking to the back garden of the lot)

All twelve (12) Apartments are considered of medium quality. They are new. They all have parking and storage.

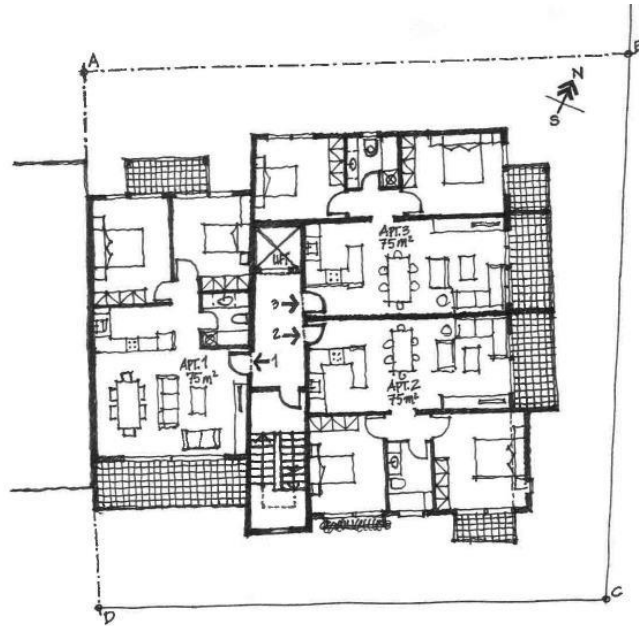


Question 1: Taking into account that **Apt. 1 on the first floor** has been sold today at a price of **€200.000**, how would you value the other apartments of the building? Please note below:

Apt.1 (1 st floor) € 200.000	Apt.2 (1 st floor) €.....	Apt.3 (1 st floor) €.....
Apt.1 (2 nd floor) €.....	Apt.2 (2 nd floor) €.....	Apt.3 (2 nd floor) €.....
Apt.1 (3 rd floor) €.....	Apt.2 (3 rd floor) €.....	Apt.3 (3 rd floor) €.....

Apt.1 (4th floor) €..... Apt.2 (4th floor) €..... Apt.3(4th floor) €.....

Project B: This Project contains **3 apartments** of the **same size (75 m²)** and with the same characteristics and equal covered verandas (13 m²) **in each floor**. The building has a ground floor (pilotis) and four (4) identical floors. The site is a corner site and there is an adjacent building at the left side of the plan. All twelve (12) Apartments are considered of medium quality. They are new. They all have parking and storage.



Question 2: Taking into account that **Apt.2 on the first floor** has been sold today at a price of **€120.000**, how would you value the other apartments of the building? Please note below:

Apt.1 (1st floor) €..... Apt.2(1st floor) **€120.000** Apt.3(1stfloor) €.....
 Apt.1 (2ndfloor) €..... Apt.2(2nd floor) €..... Apt.3(2ndfloor) €.....
 Apt.1 (3rd floor) €..... Apt.2(3rdfloor) €..... Apt.3(3rdfloor) €.....
 Apt.1 (4th floor) €..... Apt.2(4th floor) €..... Apt.3(4thfloor) €.....

Question 3: Taking into account that some parameters are constant for all apartments (location, view, age, parking, storage, construction quality, amenities, etc.), what other factors you would consider as important when valuing these apartments. Please note below:

.....

I really appreciate your time and efforts; this will be a very helpful tool for my research. I am obliged to you.