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A GIS based system for minimizing acquisition risk in Real Estate property market

Many economists have identified the main cause of recent global real estate market crisis both in the poor diffusion of systems capable of monitoring the historical property values that in the lack of public awareness about the risks of real estate investments. This paper proposes a new approach to evaluate property acquisition's risk that does not rely on a standardize appraisal indices analysis.

The proposed Geographical Information System is able to investigate the historical variation of the main real estate market indicators and to let the final user appraise the general level of real estate investment risk.

The subsequent sections of this paper will discuss about the real strength of the most common literature's algorithms used to appraise risk in real estate, then it will be explained how inexpensive information technology applications can help to increase the diffusion of awareness related to real estate market conditions. Finally it will be discussed the case of study; conclusions and some considerations about future improvements will close the study.

1. Introduction

"The subprime crisis is the name for what is a historic turning point in our economy and our culture. It is, at its core, the result of speculative bubble in the housing market that began to burst in the United State in 2006 and has now caused ruptures across many other countries in the form of financial failures ad a global credit crunch. The force unleashed by the subprime crisis will probably run rampant for years, threatening more and more collateral damage."

With this word Robert J. Shiller, ranked among the 100th most influential economists of the world, describes the 2007-2010 Real estate market bubble. The phenomenon has not yet affected the European Union with the same strength, except for some specific cases involving countries in adverse economic conditions like Ireland and Greece. The European housing market different connotation and lack of subprime mortgages have prevented, up to now, a spreading of a real estate market crisis comparable to what as been seen in USA.

Many economists have identified the main cause of recent global real estate market crisis in the poor diffusion of systems capable of monitoring the historical property values and in the scarce public awareness about the risks of real estate investments crisis (R. Bardhan, 2008 – R.J. Shiller, 2008).

This paper proposes a new approach to evaluate property acquisition's risk that does not rely on standardize appraisal indices analysis. The main goal of this approach is to decompose real estate risk into different components and let the final

user be able to manage and mix all the information layers available. In the next future, the system will be improved by adding a new layer that can collect, in real time, a great part of the property offers that can be found on public web sites. Using this methodology, the final user can check if his investment is in accordance with the real estate historical price, the relative urban quality and, finally, if and how relative costs can be actually supported by the local community median income.

Actually, the proposed application is able to analyze the historical variation of some real estate market indicators and to appraise the general level of real estate investment risk, by studying the chronological evolution of the relationship between the average housing market price and the average family income in the same urban context. This study has been made with a spatial approach in order to let the final web user be able to see, in an interactive map, how different urban zones have been involved with the historical parameter evolution. The final user can access to the application results using a WEB site based on a Virtual Earth exploration interface (e.g. Google Earth/Maps or Virtual Earth). In this way, people that are not familiar with the local Real Estate Market can familiarize with its rules and requirements in an easy and user-friendly manner.

This application can be easily customized for every international medium sized urban area (>400.000 inhabitants) and is actually able to analyze spatial information related to RE market like historical property prices, environmental and urban services quality and the median family income. All these information are geo-coded (spatially coded), come from different sources and can be mixed with a semi automated operation called "mashup"(Murthy et al, 2006). A prototype of this application has been tested on an Italian medium sized unban area (Cagliari, c.a. 400.000 inhabitants). The subsequent sections of this paper will discuss the most common literature algorithms used to quantize risk in real estate, then it will be explained how inexpensive information technology applications can help to increase the diffusion of awareness related to real estate market conditions. Finally, it will be discussed the GIS system and the specific case of study. Conclusions and some considerations about future improvements will close the study.

2. Assessing acquisition risk in real estate: global and local variables

Property acquisition, like any other financial instruments, represents investment in goods. The acquisition of these will result in an incurring monetary output (implant phase) that can generate revenue net liquidity at different times (operational phase). With a specific reference to real estate property investments, it is possible to distinguish cash flows investment / divestment from operating cash flows.

The first category includes the outputs associated with the acquisition of the property (they refer to the cost of acquisition of the property, taxes and land registry, notary charges and mortgage cost), the subsequent costs of maintenance, restructuring and improvement, and finally, the appraised money input cash flows related to the final value of the asset.

The operating cash flows includes the rents received (or saved in the case of property direct use) by the owner. It consider also the ordinary building owner's expenses such as maintenance costs, insurance, taxes, and ordinary fees for services and administration.

These input and output cash flows represent uncertain future values with regard to both their expression and their size. For this reasons, the economic sustainability evaluation of a property investment should be done by examining not only the expected average return, but also the "quality" of the measure of the hypothetical income. This quality can be considered high if there is a very good probability of obtaining the expected return, especially in a period of national economic instability.

Input and output cash flows, as well as the revaluation / devaluation of the property, may in fact differ from the average expected for the occurrence of a number of factors that can be external and common to any real estate investment or precisely referred to a specific asset.

- Among external variables, it is possible to include the possibility of general economic conditions fluctuations, interest rates variations, employment and inflation future trends, and, finally, changes in investors expectations. Usually these aspects are not correlated with local economy background and for this reason, we can define them as "global".
- The risks connected to a specific property concerning the location quality, the income of tenants and the quality and functionality of the property asset. This aspects are strictly connected to the specific "local" context.

In the last ten years, it has been possible to learn that real estate market fluctuations associated with global variables can lead to a very quick change in housing property market: the risks associated with "local" variables can be usually more foreseeable and generally tends to affect the market with less intensity. For these reasons, the methodology for measuring the risk connected to property investment is multifaceted and still not consolidated. This lack is significant especially for housing market property because it often leads common people to do an investment without knowing what is suggested by market analysis. (Shiller, 2008)

2.1 The Property and Market Rating criteria (PaM)

Being able to measure with high precision the risk of investment property is a vital competence for banking institutions that funding real estate purchases. In 2003, TEGoVA (The European Group of Valuers'Association) set up the Property and Market Rating criteria (PaM): This criteria analyzes and weighs the importance of different parameters associated with property investment risk.

PaM should be a method capable of measuring the basic quality of a property and the related mid term marketability. It is based on four key property fundamentals:

- market Enviroment (Socio economic/demographic/real estate cycle).

- Location *(Suitability/standing/transport infrastructure/facilities/environment).*
- Property *(Construction/layout/sustainability/energy performance).*
- Quality of cash flows *(Tenant situation/rental & value growth/letting prospects/vacancy situation/expenses).*

Figure 1. Property and Market Rating benchmark's weights.
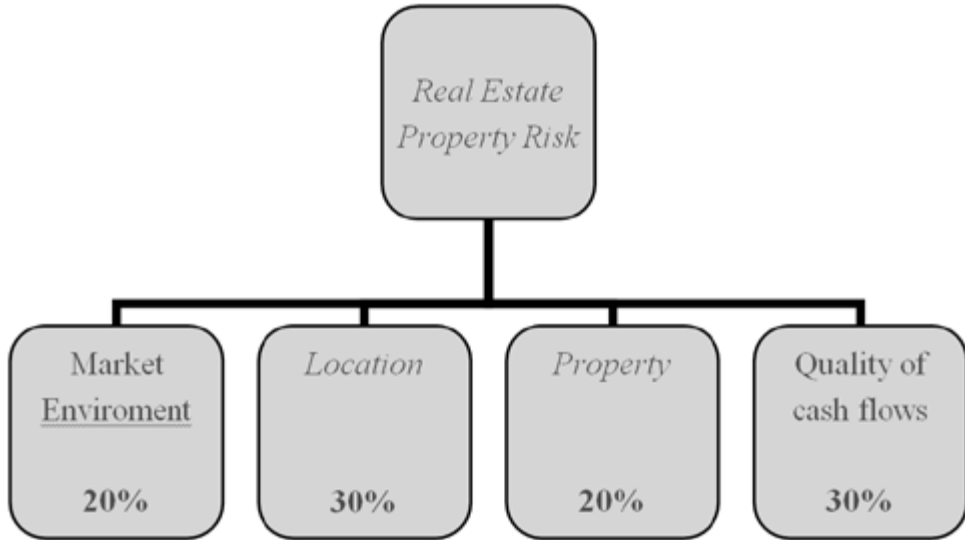
PaM is able to analyze any aspect that may influence the risk of investment property, but its extremely rigid structure is not capable of establishing a mutual relationship between the parameters influenced by the global market and those closely related to the specific local market. Some specific property qualitative issues (Location and Property) are evaluated in terms of local overall quality: considering the actual and future globalization level of property market, these issues can even be considered of relative importance if compared to the global economic risk factors (Market Environment and Quality of Cash flows).

In U.S., the sub-prime mortgages bubble burst has now re-highlighted the close relationship between the overall state economy performance and the real estate market. Indeed, the housing market financial crisis has affected other debt market like credit cards, student loans and the murky world of financial derivatives (Bardhan, 2008).

In a few words, if the trend of social and economic conditions of a nation is setting down, the quality of location and construction of a building can just moderate the expected declining of property values.

As we said before, seen from this point of view, the PaM criteria is unable to correlate the risk of investment to the "global" trend. In Pam risk assessment algo-

rithm, the whole group of quality issues related to the local market (Location and Property) have the same total weight (50%) than those most closely related to the global market (Market Environment, Quality of Cash Flows). But, as we can see, in a historical period characterized by fast and unexpected changes in economic cycles of a nation, it is obviously more correct to give the right attention to the potential presence of housing market speculative bubble rather than analyze just the qualitative aspects of a specific property (Bourassa, 1996).

2.2 Analyzing risk with other "raw" criteria: Historical price trend (Case-Shiller Index – Housing Affordability Index)

During the period before the subprime mortgage crisis, we can see, expost, that the risk associated with real estate investment can be easily identified through the historical relationship analysis of the of some "raw" indicators like property values, average income and average cost of construction.

An important contribution on this topic was provided by Shiller in 2008: he created a risk indicator capable of representing the existence and the average rough size of an housing market speculative bubble: The Case-Shiller index, actually owned by Standard & Poor's, is based mainly on four kind of dataset: a national home price index, a 20-city composite index, a 10-city composite index, and twenty individual metro area indices. Capturing approximately 75% of U.S. residential housing stock by value, the S&P/Case-Shiller U.S. National Home Price Index is actually the leading measure of United States residential real estate prices.

By a quick examination of Figure 2, it can be immediately appreciated the absence of correlation, recorded from 2000 to 2007, between the home prices evolution trend and other macro economical simultaneous indicators, like the trends of building costs, population and interest rate.

In 2006, through a simple study of the historical relationship between the average price of a house and the median household income, it was possible to identify the presence of an home price speculative bubble in the United States (Marchi, Argiolas, 2006); in such cases, the classical and always suitable parameter of Housing Affordability Index (HAI) can be an absolute reference point. In fact, the Annual Demographia International Housing Affordability Survey[1] identifies five different categories of purchase accessibility in house property market. Obviously, an high ratio between the price of a property and the household average income is a symptom of a general economic unsustainability in home property acquisition and, consequently, it will be higher the possibility of a real estate housing market bubble.

The Housing Affordability Index criteria can be useful only for a general study of the market and is not suitable for detailed examination of the risk resulting from the purchase of a single housing unit. In fact if we consider two different housing units in the same homogeneous market, one with high quality features

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[1] www.demographia.com

Figure 2. U.S. Real Home prices, 1890-2008, along with Building Costs, Population and Long Term Government Interests Rates. Source: R.J. Schiller, Irrational Exuberance, 2nd edition (Princetown University Press).
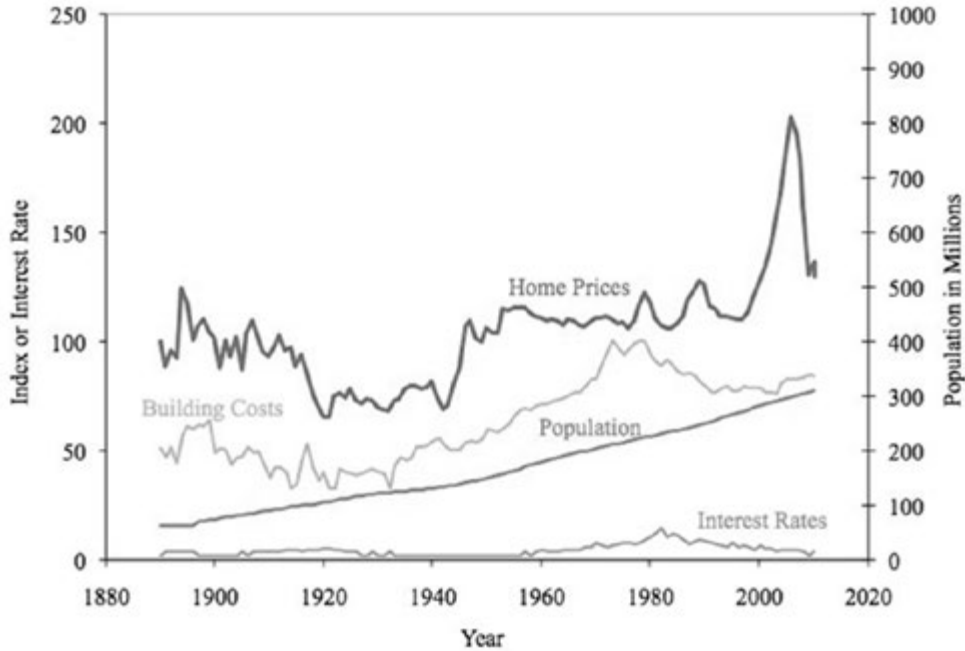
and the another in awful conditions, obviously the unit with the best quality is usually less affordable for the local community, but it doesn't mean that it will be the riskier investment. As well (Gan, Hill, 2009) the concept of affordability is inexorably influenced by the fact that the potential buyer is already related with the same real estate market: in a bubble inflated market, the credit risk associated to a house property upgrade/downgrade is different from an ordinary first-home acquisition; it can be also important to consider if the potential buyer is renting or possessing any other real estate unit.

For those reasons, Housing Affordability Index criteria must be used just as general statistical parameter to quantify the risk associated to a particular urban context, being very watchful about the specific characteristics of local housing market. From this point of view, an interesting goal of this paper is to extend the current concept of the relationship between average income and property values by giving a spatial component to the Housing Affordability Index. In fact, in any medium-sized urban context (> 400,000 inhabitants) is possible to identify some urban areas where property prices are affordable and others where the real estate purchase is unaffordable or even prohibitive for the ordinary median income citizen.

In this paper, we focus our attention to the historical evolution trend of Housing Affordability Index in order to appraise the dimension of a potential proper-

ty market bubble by measuring the gap between market expansion and contraction phases . To achieve this goal it is necessary to make a spatial analysis both of housing market values and average median income. By a practical perspective, this goal can be reached through the use of GIS applications. Considering the ratio between median household income, related to every single metropolitan homogeneous zone and distinguished in relation to six different social category, it is possible to generate a map that explain this kind of spatial HAI variation in the whole urban context.

Figure 3. ValueGIS – Residential Property values in 2007.

3. Property Investment risk awareness diffusion

A housing market bubble consists essentially in a growth of property values far beyond the threshold of local population economic sustainability. This unsustainable growth can affect the local economy by making unprofitable property acquisition or rental and, consequently, causing a quick fall in market values. The property market drop, in its turn, makes unprofitable a large quota of property investments that were made before the bubble burst, causing a great problem to the investor and, often, to the banks that borrow the money needed for acquisition.

A housing market bubble causes also a significant loss in the local production capacity and, sometimes, a consequent stagnation or recession in the local economy. Real estate market bubbles are usually caused by an excessive and general-

ized trust on the property market in a specific context that inexorably leads to a massive capital flow outer the local economy. An housing market bubble usually generates, in a very short time, an overwhelming rise in property market request, increases the values of the active offer and fuels the construction of new buildings needed to meet the increase of market demand.

Furthermore, as an increasing share of real estate value depends on the demand generated by equity investors, the time required to create an excessive demand in property market is really short and the risk of incurring in a real estate bubble are significantly higher than fifteen years ago.

As we said before, the recent sub-prime mortgage scandal is an example of how an housing bubble may quickly approach the financial market and vice versa. On the other hand, currently, the public systems capable of monitoring the status of housing market are very far from those, although improvable, available to analyze the financial market.

In fact we can evaluate the risk associated to a specific company quoted in the stock market by analyzing its economic balance, studying the historical stock price trend, evaluating its business plan and we can also evaluate the ability of its administrators analyzing the results obtained during other experiences. A similar examination cannot be performed with a property investment, both in the case where is performed directly (i.e. with the purchase of a property) - that in the case where is made by an indirect investment (i.e. acquiring stocks of a real estate investment trust). In fact, there are no officially recognized instruments for analyzing the real estate market conditions: actually it's impossible to find an official document that certificates the historical evolution of property values in cities like Rome or Milan.

The starting point for combating the economic risks associated with a real estate bubble is primarily in being certain of its existence and its size. Measures are required, now more than ever: property market can't be considered reliable without instruments able to increase the quality and quantity of objective information concerning the conditions of the real estate market.

In 2004, R.J. Schiller, stunned by the fact that did not exist an index able to represent the historical trend of property values in the United States, has developed an index of average market prices for the most representative contexts U.S. cities covering the period between now and 1890. The index has been recently acquired by Standard and Poor's which currently is in charge of it.

Schiller also affirms that during an ordinary property acquisition, the buyer comes in contact exclusively with a group of professional figures (the realtor, the bank operator and the notary) that are directly interested in buyer's future purchasing completion. It is also improbable that an ordinary citizen asks for a professional specialist consultancy which will enable him to figure out what the risks e directly related to the purchase of an house. Nevertheless this acquisition is, in most cases, the greatest economic investment of their lives.

It's so senseless that in an era historically characterized by information technology, US economy had to suffer for an housing bubble market that Alan Greenspan, Fed Chairman at the time, has attributed in 2008 in the presence of

"high" and "speculative fever" for the housing market.

Greenspan also said: "The essential problem is that our models - both risk models and econometric models - as complex as they have become – are still too simple to capture the full array of governing variables that drive global econom-ic reality. A model, of necessity, is an abstraction from the full retail of the real world" (Greenspan A., 2008). This statement, in the light of the simple graph post-ed by Schiller in 2004, seems more a justification than an objective consideration, but also shows that there are some faults in the current property market analysis tools. This tools, if combined with a policy of knowledge propagation, based for example on WEB-GIS, will allow citizens to objectively evaluate the extent of risk associated with their property investment, preventing the recurrence of similar is-sues in the future.

In fact, in the last few years, some free WEB based Territorial Information Sys-tems for a virtual exploration of the terrestrial globe, like Google Earth, Google Maps, Yahoo! Maps, or Microsoft Live Earth, raised up their diffusion. These sys-tems are so simple in their exercise that an inexperienced user can immediately make use of them having the possibility of overlapping maps with others "in-formation levels", created by the service provider or by another user. This kind of Territorial Information Systems are basically a new way for reading and store any kind of spatial related information and let a spatial web navigation possible by an interactive three-dimensional way: every digital information can be indexed using spatial relation complementary or instead of a semantic relation. The last mile stones in this web evolution is the release of Google Maps Fusion Tables and Google Earth/Maps JavaScript API that allows for embedding Google Earth/Maps into a web page. In this way, without any instrumental expense, data and geo-coded indexed information can be paired and used in a single web page that com-bines different forms of media from multiple sources. This result is obtained in a new kind of application, usually referred as "Map Mashups", that has dramatical-ly raised his diffusion on the Internet in the last few years because of the relative simplicity of overlaying all types of data on an online map that gathers data into territorial information with semantic meaning .

This kind of technology has been used to represent the results obtained with the case of study described in the next paragraph.

4. Case of study: Evaluating risk in property acquisition in a small Italian metropolitan area

This section describes a case of study that explores the potential of the pro-posed application, whose main purpose is to make a spatial analysis of housing market affordability, over the last ten years, in the metropolitan area of Cagliari (about 400,000 inhabitants, considering the wide area). This analysis will be done through the creation of a Geographic Information System characterized by a mul-tilayer approach that let users analyze information generated through a graphical representation.

As we said before, Spatial Housing Affordability Index is able to measure, through the relationship between the average income of a household and the average cost of housing, the level of affordability purchase in real estate housing. Essentially, this index expresses the number of annual family income needed to purchase ordinary mid-level housing. To calculate this value is therefore necessary to consider both the average property market values that the medium family income.

In this study, residential property market data was taken from:

- official souces like the "Agenzia del Territorio" and Cagliari's Chamber of Commerce. The historical period analyzed goes from 1999 to 2011.
- custom dataset recorded and elaborated by University of Cagliari - Real estate market observatory (Laboratorio di Estimo).

Economical data, related to average gross revenues was taken from:

- Data from Italian Department of Economy and Finance, processed by Il Sole 24 Ore (http://www.ilsole24ore.com/).
- Data published by the website site-www.comuni italiani.it and Centro Studi L'Unione Sarda.

Starting from the average gross revenues, it is possible to obtain the average net income by applying the corresponding rate tax. Obviously, this approach can serve a certain uncertainty that does not tend to significantly influence our results. We considered five different categories of households and it was assumed that the buyer's family owns the cash needed to pay the 20% of the property value. The remaining quota is supposed to be paid through a bank loan. The considered five social categories are the following:

1. young single worker who buys a 60 sqm apartment.
2. male single worker (low-income) with a wife and 1 child who buys an 80 sqm apartment.
3. bi-income young couple with 1 child who buys an apartment of 90 sqm.
4. male single worker (medium-income) with a wife and 2 sons who buys an apartment of 90 sqm.
5. Bi-income and wealthy couple that buy an apartment of 90 sqm.

Results show that the Housing Affordability Index expresses a considerable difficulty of the local community in the acquisition of a suitable housing unit. This aspect is due to the fact that during the period from 1999 to 2009 property prices rose by about 100% while the citizen average income didn't follow the same trend.

Furthermore, by examining the historical evolution of the HAI index, it appears evidently that only during the period 1999/2000 residential property purchase could be considered affordable for every single one of the five kinds of households social category considered. Instead, from 2000 until 2008 the HAI index rose sharply making virtually impossible to purchase a property, especially for single-income families. Beyond 2008, this index has almost stabilized.

Result also confirms that the analyzed property housing market is actually in a great uncertainty phase related to the absence of future developments. Accord-

ing to market players, at present, because of the global economic crisis, the national number of property acquisition in the last three years is very small compared to the period 2004-2008.

In the next future, without an implausible of local medium income increasing, it will be probable a forthcoming significant reduction in residential property values: at present, doing property offers quick examination, it is possible to note a significant variation of property price offer for similar quality residential units depending on seller expected (needed) time to sell.

The housing market is consequently slowed down and its future will depend from the short/medium-term economic trend: if the economic crisis will be resolved quickly the market will slowly take a breath and settle down to values sustainable by the local community, otherwise, in near future, this step will be surely characterized by a significant decline in average selling prices, that could lead to a local real estate market crisis absolutely unimaginable until a few years ago.

Specifically, taking into account, the category "young single worker who buys a 60 square meter apartment", the HAI historical variation shows that, in 1999-2000, this category could easily afford a residential property purchase in almost all the urban areas. In the hinterland zone, this purchase could be done easily (2.54 <HAI> 3.00). During the period between 2001 and 2005, residential property acquisition becomes very difficult in the whole urban context: in particular, buying an home located in the suburbs is even more complex than doing the same investment in the metropolitan highest quality zone during1999-2000. Between 2008 and 2009, home purchase has become virtually impossible in the whole metropolitan context.

Figure 4. Housing Affordability Index between 1999 and 2009.

HOUSING AFFORDABILITY INDEX						
Household category	Year	Historical Center	Midtown	Residential Zones	Extended midtown	Suburbs
young single worker who buys a 60 square meter apartment	1999	3,91	4,20	3,91	3,91	2,54
	2000	4,13	4,88	4,60	4,13	3,00
	2001	5,10	5,90	4,74	4,20	3,58
	2002	4,58	6,14	6,04	4,87	3,90
	2003	5,09	6,18	6,73	5,09	4,18
	2004	4,94	6,00	6,53	5,29	4,24
	2005	4,68	5,48	5,97	5,16	4,03
	2006	5,42	6,50	6,81	5,88	4,80
	2007	5,98	6,90	6,90	5,98	5,06
	2008	5,91	6,82	6,82	5,91	5,00
	2009	6,12	7,01	7,01	6,12	5,22

Anyway, beyond those that could be the next market changes, one of the most alarming characteristic of this matter is the lack of public objective information about the actual condition of real estate market. In the current market situation, the citizen that is going to buy an home property must have the opportunity to be informed about the risks related to his potential investment.

For this reason, the proposed application was developed complementary with a web-GIS interface that can actually be consulted at www.valuegis.com. Browsing through different layers, it's possible to see the average market values recorded in the metropolitan area and compare the level of home property investment related to a great part of the metropolitan contest. In addition, the final user can easily access to all the real estate literature reference needed to understand the meaning of the values reported in the information system.

5. Conclusions and future system improvements

The proposed GIS system allows to access to the produced information in an easy and quick way and to perceive the historical evolution of real estate market conditions and risk. However, future developments will allow to improve the quantity and the quality of collected information. In particular, among the future research application goals, it plays a crucial role the study of the spatial dimensions of the Housing Affordability Index related to an extended portion of the urban area and considering the average median income of each different municipality. With this application's extension, it will be possible to study the specific HAI value of reported to the residential units capacity of every single municipal homogeneous area. In this way, the final user will be able to understand how much of the urban area is available for purchase depending to the social category considered. This implementation will allow an easy comparison between different municipalities and it can be perceived the different accessibility of the related market offer.

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