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Abstract: Early warning, neural networks, expert, decision support, fuzzy and other systems, barometers, housing and real estate bubble indexes have been developed in an effort to analyze and manage crises in housing market. Scholarly literature employs various concepts of housing market crises concepts, including overheated, heating-up, stable, stagnant market, freezing, healthy housing. There are numerous interest groups operating at the meso and macro levels of the housing market who would appreciate receiving recommendations during the various stages of a crisis in the housing market. Therefore the Crisis Thermometer for Housing Market Recommendations was developed applying the aforementioned intellectual systems and concepts along with the long-term backgrounds of these authors.

Different countries frequently select different strategies and tactics in their efforts to lessen the effects from a housing market crisis. This is entirely natural due to differing economies and markets of different countries, as well as their respective legal, institutional, technological, technical, social, cultural, political, psychological, ethical and other kinds of aspects. Traditionally an analysis of a housing market crisis is grounded on economic, legal, institutional and political aspects. Less attention is paid to social, cultural, ethical, psychological, emotional, religious, demographic, spiritual and educational aspects of crisis management. These sorts of factors are additionally used for assessing a housing market crisis with the aid of the Thermometer and for submitting personalized recommendations. The innovativeness of the Crisis Thermometer, developed by the authors herein, is primarily that it automatically determines the "temperature" of housing market, compiles numerous alternative recommendations applicable to a specific user, performs a multiple criteria analysis of these recommendations and selects out the ten most rational ones for that user. This article overviews the Housing Market Crisis Management Model and its respective Thermometer and presents a practical example to demonstrate how the developed Thermometer works. This article also presents the validation of the proposed Model and Crisis Thermometer.

Dear Editorial Board,

Please find below the relevant information.
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Specify special considerations that should be given to the paper (if any).

The authors of this article have been developing built environment intelligent systems at Vilnius Gediminas Technical University since 1989. They received their first grant in the field of sustainable housing intelligent systems in 1989 [1]. The authors of this article (Zavadskas and Kaklauskas) started publishing books on intelligent systems in 1991/1992 (Aalborg University, Denmark [2, 3]). We keep publishing our new research findings obtained so far in the field in top journals around the world (Kaklauskas 2015, etc.).

[1] Разработка программно-методического комплекса на ПЭВМ для многовариантного проектирования малоквартирных домов с получением чертежей планов, разрезов, фасадов, перспектив, технико-экономических показателей и качественных характеристик. Москва, ЦНИИ Проект. 1989.
[2] E. K. Zavadskas, A. Kaklauskas. Automated multivariant design of buildings, multi-purpose comprehensive evaluation and selection of the most efficient versions / Aalborg University. Aalborg, Denmark: Aalborg Universitetscenter,1991. 66 p.
[3] E. K. Zavadskas, A. Kaklauskas, E. Bejder. Multiple criteria analysis of projects / Vilnius Technical University, Aalborg University. Aalborg: Aalborg Universitetscenter, 1992. 93 p.
E. K. Zavadskas, A. Kaklauskas.
Kaklauskas, A. Biometric and Intelligent Decision Making Support. Series: Intelligent Systems Reference Library, Vol. 81. 2015, XII. Springer-Verlag, Berlin, 228 p.

Web of Science Citation Report for Prof. A. Kaklauskas:
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- H-Index: 20;
- Sum of times cited: 1369;
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Editor of International Journal “Engineering Applications of Artificial Intelligence”

The authors of this article have been developing Intelligent systems for real estate and construction crisis management at Vilnius Gediminas Technical University since 2007.

Worldwide quite many systems for managing crises in construction, real estate and their different segments have been developed. The global innovativeness of the Construction and Real Estate Crisis Thermometer, developed by the authors herein, is primarily that it automatically determines the “temperature”, of a construction and real estate, compiles numerous alternative recommendations applicable to a specific user, performs a multiple criteria analysis of these recommendations and selects out the ten most rational ones for that user. No other system in the world performs these functions to date.

A brief background regarding the research involved or how the data was collected. It is also useful to provide the Editor-in-Chief with any information that will support your submission (e.g. original or confirmatory data, relevance, topicality).

The authors of this article have been involved in the research and have been developing sustainable construction and real estate crisis management decision support and recommender systems from 2007. Also, this article was written and the data were collected based on the original

experience of the authors accumulated through participation in various national and international research projects.

We confirm that this paper has not been published elsewhere.

Reviewers, please supply their full contact details including an e-mail address.

Names, addresses, and email addresses of three expert referees.

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Finally, this paper is our original, unpublished work. It has not been submitted to any other journal for reviews.

Kind Regards,

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We are very grateful to our reviewers for their valuable suggestions!

Questions	Answers
Reviewer #2:	
1. Author(s) should be more consistent on which decimal separators to choose: dots or comma. For example 33, 65 (page 16) or 5.8 (Table 1, page 20). There are many similar instances.	Done
2. Tables are generally in English, but some text is still in Lithuanian (table 2)	Done
3. Language editing should be performed more carefully.	Done
Reviewer #2: I read it - confused about the aim of the research, the choice of variables for the model, the model specification, its validity etc.	
Aim of the research	The overall aim of the research was to develop the Crisis Thermometer for Housing Market Recommendations, a personalised recommendation tool that enables housing market stakeholders (clients, tenants, government officials, financial institutions, insurance companies, real estate operating companies, developers, investors) to become co-creators of an efficient and affordable housing market. The Crisis Thermometer mixes text mining, recommender, knowledge and multiple criteria decision support subsystems; it can efficiently combine and analyse all relevant integrated data, information and knowledge (economic, legal, institutional, political, social, cultural, ethical, psychological, emotional, religious, demographic, spiritual and educational), automatically determine the "temperature" of the housing market, compile multiple alternative recommendations applicable to a specific stakeholder, perform a multiple criteria analysis of these recommendations and select ten most rational ones for that stakeholder (See Chapter 1 "Introduction").
Choice of variables for the model	It is described in the Chapter 3 "Choosing Variables for the Model" of the article.
Model specification, its validity	It is described in the Chapter 2 "Specification of the Housing Market Crisis Management Model" and Chapter 6 "Validation of the Model and Crisis Thermometer for Housing Market Recommendations" of the article.

*Title page with author details

Crisis Thermometer for Housing Market Recommendations

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Abstract. Early warning, neural networks, expert, decision support, fuzzy and other systems, barometers, housing and real estate bubble indexes have been developed in an effort to analyze and manage crises in housing market. Scholarly literature employs various concepts of housing market crises concepts, including overheated, heating-up, stable, stagnant market, freezing, healthy housing. There are numerous interest groups operating at the meso and macro levels of the housing market who would appreciate receiving recommendations during the various stages of a crisis in the housing market. Therefore the Crisis Thermometer for Housing Market Recommendations was developed applying the aforementioned intellectual systems and concepts along with the long-term backgrounds of these authors.

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Keywords: Housing Market, Crisis Thermometer, Variables, Model Specification and its Validity, Modelling, Crisis Management, Forecasting

Highlights

The global innovativeness of the Crisis Thermometer for housing market recommendations, developed by these authors, constitutes:

- defining the “temperature” in the housing market
- compiling numerous alternative recommendations applicable to a specific user
- performing an analysis of these tips and selecting out the ten most rational ones
- performing a validation of the Model and Crisis Thermometer

Crisis Thermometer for Housing Market Recommendations

Abstract. Early warning, neural networks, expert, decision support, fuzzy and other systems, barometers, housing and real estate bubble indexes have been developed in an effort to analyze and manage crises in housing market. Scholarly literature employs various concepts of housing market crises concepts, including overheated, heating-up, stable, stagnant market, freezing, healthy housing. There are numerous interest groups operating at the meso and macro levels of the housing market who would appreciate receiving recommendations during the various stages of a crisis in the housing market. Therefore the Crisis Thermometer for Housing Market Recommendations was developed applying the aforementioned intellectual systems and concepts along with the long-term backgrounds of these authors.
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1. Introduction

The analysis and management of crises in housing and real estate has involved developments such as housing and real estate warning (Dreger and Kholodilin 2011, Dreger and Kholodilin 2012, Hua 2011, Li *et al.* 2009), neural networks (Khalafallah 2008, Kauko 2012), expert (Majeske and Lauer 2013, Jacob and Marsden 1990), decision support (Introne and Iandoli 2014), fuzzy (Shekarian and Gholizadeh 2013, Mao and Wu 2011) and other systems, housing barometers (Kolko 2014, Sichelman 2002) and housing and real estate bubble indexes (Bosley 2013, Veraguth 2011). Discussions on several characteristic systems follow to serve as examples.

Excessive speculation on asset markets can cause significant macroeconomic losses in terms of production and employment. Such developments should be detected as early and as reliably as possible in order to enable corrective action through adequate economic policy measures. This is the goal of the Early-warning system, which DIW Berlin developed on behalf of the Federal Ministry of Finance for the housing market. The Early-warning system predicts price surges on the real estate market that were caused by speculation. As long as speculative price developments are detected quickly, economic policy has enough leeway to find an adequate response and possibly prevent further expansion of the bubble (Dreger and Kholodilin 2011).

The Early-warning system can inform investors about the general development and structure of the real estate industry, hence helping them to optimize their investment opportunity and structure. Additionally potential investors can learn about the development trends of the real estate market and then seize opportunities while avoiding risks. Early-warning reports can offer optimized consultation for real estate agencies, hence improving the accuracy of the judgments consultants make on the future development of the real estate market as well as their profits by providing agency services (Hua 2011).

Dreger and Kholodilin (2012) suggest an Early-warning system based on three alternative approaches: signaling approach, logit, and probit models. It is shown that the latter two models allow much more accurate predictions of housing price bubbles than the signaling approach does. The prediction accuracy of the logit and probit models is high enough to make them useful in forecasting future speculative bubbles in the housing market. Thus this method can be used by policymakers in their efforts to detect house price bubbles in a timely manner and to attenuate their devastating effects on the domestic and the world economy (Dreger and Kholodilin 2012).

Li *et al.* (2009) developed a new macro-control system for the real estate market that is based on information systems, specifically, a real estate warning system, a confidence index system and a simulation system. The System consists of two index systems — the Real estate warning system (REWS) and the Real estate confidence index (RECI). REWS consists of the following indicators: personal housing loans/real estate loans, real estate (RE) development loans/medium or long-term loans, growth rate of total sale area of commercial housing, growth rate of total completion area of commercial housing, growth rate of the area of new commercial housing projects, growth rate of land development, growth rate of completing RE investment, RE investment/fixed assets investment and RE investment growth rate/GDP growth rate. The RECI index system is divided into four levels. The first level is a composite index level. The second is a nominal index level, which encompasses indexes such as the latent demand index, latent supply index and efficient S&D index. The third is a sub-index level and it consists of such indexes as the market index, PP (purchase power) index, population index, price index and others. The fourth is the basic index level composed of indexes such as capacity rate index, land increment index, sales index; building area index and such. Li *et al.* (2009) tested the offered macro-control system based on survey data from the Shenzhen REM, and their results demonstrated that the system can accurately and effectively reflect the status and development trends of the real estate market.

Khalafallah (2008) developed artificial neural network based models to support real estate investors and home developers in this critical task. The models utilize historical market performance data sets to train the artificial neural networks in order to predict unforeseen future performances. The main variables, which are considered the main indicators of the possible change of the price of real estate housing in the near future, which are included in artificial

neural networks structure are time, average interest rate, percentage change in sales volume compared to the previous year, percentage change in the median price for housing compared to the previous year, average days a housing unit remains on the market, the volume of inventory and the inventory supply by months. The model testing and validation showed that the error in prediction ranges from –2% to +2%.

Trulia's Housing Barometer (Kolko 2014) highlights five measures: new construction starts, existing home sales excluding distressed sales, delinquency + foreclosure rate, employment rate for 25-34 year-old (comprising a key age group for household formation) and first-time homeownership home-price levels relative to fundamentals. The first four measures are reported monthly. To reduce volatility, Kolko (2014) use three-month moving averages for these measures. The fifth, prices from the Kolko (2014) Bubble Watch, is a quarterly report. Kolko (2014) compares for each indicator the latest available data to (1) its worst reading (during recession) for that indicator during the housing bust and (2) its pre-bubble "normal" level.

Various thermometers are employed in different human activities: Depression Thermometer, Anxiety Thermometer, Help Thermometer, Emotion Thermometer, Thermometer Screen for Mood Complications of Cardiovascular Disease (Mitchell et al. 2012), Anger Thermometer (Goldstein et al. 2013), Panic Thermometer (A Complete Resource… 2014), Problem Thermometer (Michigan State University 2014), Mood Thermometer (Gil et al. 2005), Fear Thermometer (Heyne 2002), Thermometer for Happiness (Karambelas 2013), Distress Thermometer (Patel et al. 2011), Feeling Thermometer (Swanbrow 2001) and Debt Thermometer (Free Debt Thermometer 2014). As an example, a concise analysis of the Thermometer for Happiness and Feeling Thermometer follows.

The hedonometer measures Twitter's Gardenhose feed, a sampling of about 50 million messages tweeted each day, analyzes 10,000 of the most commonly used words and provides a happiness factor on a 9-point scale. The hedonometer records and charts the global psyche based on the millions of words posted to Twitter each day. It functions much as a thermometer does. Taking the temperature of one molecule (in this case, a tweet) might not be particularly revealing, but the aggregate picture can be meaningful (Karambelas 2013).

The Feeling Thermometer, which National Election Studies employs regularly, asks respondents to rate candidates on a scale of 0 to 100, where 0 indicates the coldest feeling and 100 – the warmest, while 50 is neutral, neither warm nor cold. Thus it not only shows whether a respondent views a candidate positively or negatively but also the degree of that feeling. The Democratic Party used this thermometer to rate their candidates in 2008. Hillary Clinton wound up at the top. Nationally, she scored 82%. This is a higher score than the other, most positively rated Democrats received – Barack Obama with 72% and John Edwards with 68% (Saad 2007).

The Institute for Social Research survey found that Americans suffered psychologically from the September 11, 2001 terrorist attacks in its special survey on the political, social, psychological and economic impacts of the terrorist attacks. Nonetheless, it also found that the terrorist attacks also had some positive impact on the American psyche. Black, Hispanic and Asian Americans get higher ratings on "feeling thermometer". On the "feeling thermometer" included in the survey, Black Americans were rated positively by 67 percent of respondents, compared with 63 percent of people surveyed in 2000. Hispanic Americans were rated positively by 64 percent of respondents, compared with 58 percent in 2000. Asian Americans were rated positively by 62 percent of respondents, compared with 61 percent in 2000. Even White Americans received

better ratings in the survey—78 percent of respondents rated them positively in the wake of the terrorist attacks, compared with 72 percent in 2000 and 63 percent in 1998 (Swanbrow 2001).

The systems and thermometers mentioned earlier do not establish the "healthiness level" of the housing market and do not provide personalized recommendations to the interested groups in various sectors.

The overall aim of the research was to develop the Crisis Thermometer for Housing Market Recommendations, a personalised recommendation tool that enables housing market stakeholders (clients, tenants, government officials, financial institutions, insurance companies, real estate operating companies, developers, investors) to become co-creators of an efficient and affordable housing market. The Crisis Thermometer mixes text mining, recommender, knowledge and multiple criteria decision support subsystems; it can efficiently combine and analyse all relevant integrated data, information and knowledge (economic, legal, institutional, political, social, cultural, ethical, psychological, emotional, religious, demographic, spiritual and educational), automatically determine the "temperature" of the housing market, compile multiple alternative recommendations applicable to a specific stakeholder, perform a multiple criteria analysis of these recommendations and select ten most rational ones for that stakeholder.

The Crisis Thermometer was developed on the bases of the aforementioned housing and real estate warning (Dreger and Kholodilin 2011, Dreger and Kholodilin 2012, Hua 2011, Li *et al.* 2009), neural networks (Khalafallah 2008, Kauko 2012), expert (Majeske and Lauer 2013, Jacob and Marsden 1990), decision support (Introne and Iandoli 2014), fuzzy (Shekarian and Gholizadeh 2013, Mao and Wu 2011) and other systems, as well as housing barometers (Kolko 2014, Sichelman 2002), housing and real estate bubble indexes (Bosley 2013, Veraguth 2011) and the recommender and intelligent decision support systems these authors had developed earlier. The Thermometer is described in detail in the fourth section of this article.

The structure of this paper is as follows. Following this introduction, Section 2 describes specification of the Housing Market Crisis Management Model. Section 3 provides a description of the choosing variables for the Model. Sections 4 and 5 provide a brief review of the Crisis Thermometer and the Case Study. Section 6 follows with validation of the Model and Crisis Thermometer for Housing Market Recommendations. Finally the concluding remarks appear in Section 7.

2. Specification of the Housing Market Crisis Management Model

The specification of the Housing Market Crisis Management Model is constructed using well-understood text mining, recommender, knowledge and multiple criteria decision-making methods. Tasks for the Crisis Thermometer for Housing Market Recommendations are specified by defining how they affect the state of housing market crisis management. Housing market crisis management is therefore analysed using integrated data, information and knowledge (economic, legal, institutional, political, social, cultural, ethical, psychological, emotional, religious, demographic, spiritual and educational) and also text mining, recommender, knowledge and multiple criteria decision-making approaches.

The traditional analysis of a crisis in the housing market (HM) is grounded on legal, institutional and political aspects. The opinion of Lu and So (2005), as one example, is that, although the sudden collapse of the Asian economy during the 1997 financial crisis was a topic of many studies, most of these studies concentrated on primary economic principles. What receives far less attention regarding crisis management are its social, cultural, ethical, psychological, religious, demographic, spiritual and educational aspects. It is essential to analyze the life cycle of a crisis in the HM in a complex fashion involving a comprehensive system of criteria for a fully integrated discussion (see Figure 1).

Figure 1. Aspects of crisis management in the housing market

Economic and technological triumphs alone cannot assess how to overcome a crisis and pursue advancement in the HM area – true advancement also encompasses elements of values. Even a market cannot perform its functions, unless its activities are based on solid, mutual trustworthiness.

The authors propose the specification of the Housing Market Crisis Management Model with the following eight stages:

Stage I. A written comparison is performed of crisis management in the housing market (HM) in developed countries and in Lithuania that includes:

− describing the effectiveness of crisis management and compiling a system of criteria (using relevant literature and expert assessment methods)

− writing-up the criteria selected regarding the existing condition of crisis management in developed countries and in Lithuania conceptually and quantitatively.

Stage II. A determination of the most suitable crisis management practices for Lithuania is made with consideration of actual conditions that includes:

− establishing the global development trends in crisis management (general, repetitive characteristics)

− establishing differences in cohesive crisis management in developed countries and in Lithuania

− establishing strengths and weaknesses of these differences for Lithuania

− establishing the most suitable practices of crisis management for Lithuania in consideration of actual conditions

− assessing differences in the know-how of interested groups about the best practices globally and the practices they actually use.

Stage III. The development of the database of the Crisis Thermometer for Housing Market Recommendations with the following types of tables: general information tables, crisis management decision-making tables, crisis management alternative design tables, crisis management recommendation tables, alternative design tables for crisis management recommendations, and assessment tables for crisis management recommendations.

Stage IV. The development of the model base of the Crisis Thermometer for Housing Market Recommendations. The model base includes the following models with respective functions: the compilation model for housing market (HM) crisis management alternatives, the calculation model for preliminary criteria weights (expert judgment methods applied), the calculation model for criteria weights , the HM crisis management alternative designing model, the multiple criteria analysis and prioritisation model, the calculation model for utility degrees, the HM Crisis Thermometer model, the compilation model for recommendation alternatives, the designing model for recommendation alternatives, and the HM crisis management recommender model.
Stage V. The development and application of the Crisis Thermometer are completed to provide ratings on a scale in which scores from T_{min}=32.0° to T_{max}=42.0° indicate a cooling/overheating housing market. The "temperature" of a HM depends on a number of variables at two levels, the meso and macro environments.
Stage VI. Changes reflected by the Crisis Thermometer are analyzed regarding how changes in the meso and macro environments correspond with changes in the housing market's "temperature", and the extent to which the goals pursued by various interested parties are met.
Stage VII. General recommendations are formulated on how to improve the level of effectiveness of interested groups operating in a HM.
Stage VIII. Specific recommendations are formulated on how to overcome a crisis offering several alternatives for each general recommendation proposed in Stage VII.
Stage IX. A multicriteria analysis on the components of crisis management in the HM is performed, selecting the most effective crisis management alternatives, and then interlinking the matched, rational components of crisis management derived in this stage into a comprehensive, cohesive process of crisis management.
Stage X. Effective crisis management decisions are put into practice, and transformational training and behavioral changes are implemented.

3. Choosing Variables for the Model

Various Early Warning Systems relevant to the housing and other related sectors are being developed worldwide (Bunda & Ca' Zorzi, 2010; Huang & Wang, 2005; Ho, Wang & Liu, 2012; Lind 2008). They utilize some certain indicator system for analyzing, forecasting and issuing warnings on foreseen crises thereby providing sufficient time to prepare for them. These systems employ various models, methods and warning indicator systems. The development of the Crisis Thermometer involved special attention to the formation of a system of indicators. Therefore characteristic warning indicator systems are discussed further as examples (Ponomarenko, 2013; Bunda & Ca' Zorzi, 2010; Agnello & Schuknecht, 2011; Huang & Wang, 2005; Borio & Lowe, 2002; Ho, Wang & Liu, 2012; Lind 2008; Hui & Liang 2015, Hui & Wang 2014, Hui & Bao 2013).

Ponomarenko (2013) applies recently developed, early warning indicator systems to a cross-section of emerging markets finding that models designed to predict asset price booms/busts in advanced countries may be useful for emerging markets. This scholar constructs a discrete choice model fitted to predict asset price booms/busts on purely a cross-section of emerging market economies with little or no modification. According to this model, Ponomarenko (2013) considers four categories of explanatory variables: asset price indicators (aggregate and housing price indices), real sector indicators (GDP, consumption and investment), financial variables (money and credit) and capital inflows (total and non-FDI). The investment to GDP ratio is additionally considered. Capital inflows are summed over four quarters and are in ratios to GDP. All variables that are not in deviations from trend are demeaned.

The contribution of the research by Bunda and Ca' Zorzi (2010) is to revisit the literature on the Early Warning System (EWS) by analyzing selected episodes of financial market crises, i.e., those preceded by a spell of credit and real estate expansions. Bunda and Ca' Zorzi (2010) identify several macroeconomic indicators of vulnerability for currency/banking crises that already become apparent during the boom phase. Bunda and Ca' Zorzi (2010) include the rate of change of the real, effective exchange rate to proxy — albeit imperfectly — and a large deterioration in price competitiveness, which may have a destabilizing role on the financial system. Furthermore these researchers also include the current account as a share of GDP, as beyond its competitiveness relevance; it may also signal to what extent a country is reliant on external financing. In the domain of the domestic real and public sector, the indicators chosen by Bunda and Ca' Zorzi (2010) are standard, i.e., real GDP growth, fiscal balance and public debt to GDP ratios. They follow the literature in the domestic financial sector domain and include domestic credit to the private sector-to-GDP and house prices, both expressed as growth rates.

Agnello and Schuknecht (2011) look at real estate price booms/busts in industrialized countries over the period of 1980-2007. A number of explanatory variables are considered in the analysis along the lines of the empirical literature. These scholars include the following set of controls in their final specification of their boom and bust model:

- A set of variables (*X1*) reflecting economic fundamentals:
  - *Growth in per-capita real GDP* may be related to housing price deviations from trend. Hence a higher growth of personal income may be seen as positively associating with a higher probability of a housing boom and lower growth, with a higher probability of a bust.
  - The *level of short-term interest rates* affects household debt financing conditions; an increase should decrease the probability of a boom and increase the chance of a bust.
  - The *growth rate of real credit to the private sector* also mirrors household debt financing conditions and the degree of credit-rationing. More/less credit growth should hence be correlated with a higher boom/bust probability.
  - The *growth rate of the global-liquidity variable* aims to test the role of international factors and notably cross-country spillovers via generously/sparsely available liquidity in other countries.
- A demographic variable (*X2*) to account for related demand-side effects on real estate prices: *The growth rate of working-age population* may play a role in explaining housing demand and house prices over longer horizons, when additionally given long supply lags in the construction sector. The expectation is that higher growth increases the likelihood of a boom.

- A set of dummies (*X3*) controlling for the structural characteristic of local mortgage markets and the banking sector: *A mortgage market deregulation* should increase the probability of a subsequent boom. The deregulation process, which took place in the early to mid-1980s in many advanced economies, heightened competition in the banking sector and broadened the access households have to mortgage credit.

Huang and Wang (2005) present a pre-warning system developed to monitor and provide pre-warning to governmental decision makers in the Shenzhen property market. These scholars analyze the essential factors affecting the Shenzhen real estate market. The following macro-economic measures are selected to reflect the macro-economical situation of the property market: growth rate of property development, GDP growth rate, total amount of property investment (fixed assets investment), development loan (medium- to long-term loan balance of financial organizations) and individual mortgage loan (development loan).

Borio and Lowe (2002) imply that the combination of asset prices, real sector and financial (e.g., money or credit) variables should be monitored for a timely prediction of asset price bubbles.

The values of the constructed early warning indicators, i.e., the deviations from trend, growth rate or phase severity above/below certain thresholds may then be labeled as booms/busts. The thresholds are usually defined in terms of percentiles or proportion of standard deviation. These may be country-specific (in which case we look for events that are exceptional for a given country) or computed for an entire cross-section (thus discriminating between the normal cyclical fluctuations that may be observed in most economies and their respective outstanding booms/busts) (Ponomarenko 2013).

Ho, Wang and Liu (2012) develop the Genetic Artificial Neural Network Model for the Monitoring and Early Warning of Urban Housing Market. The developed Model is using the warning indicators (five market conditions of the overheated, heating-up, stable, stagnant and freezing markets) that reflect the urban housing market conditions, including the city's total population, GDP, housing stock, vacancy volume, housing prices, new case standard unit prices, purchases of housing loan balances, construction loan balance, period average housing loan amount, housing price-income ratio, supply and demand ratio and vacancy rate.

The aforementioned subsystems of early warning indicators can also be considerably complicated. As an example, there is a discussion on the asset price indicator and housing affordability.

The asset price indicator is usually examined in terms of growth rates or deviations from trend. Another method suggests analyzing asset price developments in terms of cyclical fluctuation phases, the severity of which both amplitude and duration characterize. This method is less sensitive to short-run fluctuations but may be more difficult regarding interpretation (e.g., one may argue that a prolonged period of steady asset price rises does not necessarily represent a boom) (Ponomarenko 2013).

The concept of "housing affordability" is itself highly polysemous, having a number of definitions and methodological approaches used for its measurement. These include house price to income ratio, residual income after housing costs and purchase and repayment affordability. Although there is no agreement on a single measure, the housing expenditure-to-income ratio is employed most frequently. The dichotomy between what is affordable and what is unaffordable is typically delineated by a 30%-of-income threshold with housing costs greater than this deemed unaffordable. While the qualifier "arbitrary" or "subjective" often prefixes a discussion about

such affordability thresholds, their ubiquity suggests some level of value (Mattinglya and Morrissey, 2014).

Various housing market indicators keep on being developed in an effort to establish the existing housing situation. Such indicators are presented henceforth.

Housing was likely to cool off in 2005, after one of the greatest booms in history. While prices didn't collapse nationally, some overheated markets witnessed sharp price declines in the next year or so. A basic summary of the progress of *housing indicators for U.S. cities* (how bubbly is housing market) involves the following: change in house prices, housing opportunity index, luxury housing affordability index, housing volatility index, change in employment, change in single-family house construction permits, cost of renting in proportion to cost of owning, housing cycle barometer affordability and homes bought as investments (Interactive Table 2009).

The housing market indicators used for analysis according to the U.S. Residential Real Estate Investment & Business Guide for Foreigners (2006) include housing affordability (price to income ratio, affordability index and median multiple), housing debt (housing debt to income ratio or debt-service ratio, housing debt to equity ratio [also called loan to value]), housing ownership and rent (housing prices and housing rents ratio, ownership ratio, price-to-earnings ratio, price-rent ratio, gross rental yield, occupancy rate (opposite of vacancy rate), housing price indices and the like.

The Bank of England Committee agreed that it would closely monitor *housing market indicators* covering house price affordability and sustainability, indicators of indebtedness, underwriting stands, exposures of lenders to highly indebted households and the reliance of lenders on short-term wholesale funding (Treanor 2013).

Baumohl (2005) analyses the major house market indicators, which are existing home sales, sale price of existing homes, the housing affordability index, new home sales sold and for sale, total construction spending, total housing units started and the Housing Market Index.

Initiatives to improve data availability and quality (especially in the commercial real estate segment) can help to discover better yardsticks indicating real estate booms (such as price-income and price-rent ratios, capitalization rates, measures of credit growth, balance sheet exposure and leverage). These can be developed to guide the risk assessments posed by a run-up in prices and the decision to take action against “bad” booms (Crowe et al. 2013).

Xiaoling (2007) developed in a report from China Academy of Social Science systematic list of indicators. The systematic list of indicators is based on price to income ratios, the price increase rate, rent to price ratios and investor psychology.

From a policy point of view the most important aspect of bubble theories is their predictive ability. Can they be used to indicate the probability that a period with a dramatic price increase quickly will be followed by a dramatic fall in prices? An indicator system would be a set of characteristics that are such that if they are at hand during a period of quickly rising prices, then it increases the probability that prices will fall dramatically soon (Lind 2009).

“Probability” can be given both more “objective” and more “subjective” interpretations. The objective interpretation would focus on characteristics that have been observed in early phases of earlier bubbles, and draw the conclusion that if such characteristics are observed now then the likelihood of a downturn is higher. The more subjective, or theoretical interpretation, would go

something like the following. In the long run, the market is determined by rational factors, by factors that a knowledgeable actor would take into account, and by the weight that the knowledgeable actor would give them. If during a certain period with increasing prices it is observed that other factors are affecting the behaviour of the actors, then the probability that prices will fall soon is higher. The "irrational" factors that affect the price would then indicate that there is a bubble (Lind 2008).

To build the Crisis Thermometer, the authors used indicator subsystems that are based on the factors discussed in the research literature overviewed above. Our basis was Lind's (2008) proposed system of seven indicators, which are prices and incomes, housing expenditure, housing supply, buyer expectations about prices, buyer impatience and financial risk taking, the credit market, and speculative behaviour. Other researchers and practitioners also analysed these indicators looking at them in the context of bubbles in housing markets. The subsystem of prices and incomes, for instance, often includes the indicators "housing price to income ratio" (X_{11}: Canada's Housing Bubble 2013; Richards, A. 2008; Ritholtz, B. 2010; Canadian Housing Price Charts 2013) and "housing affordability" (X_{12}: Federal Reserve Bank of San Francisco 2003; Morel, D. 2009; Heartland funds 2012) (see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638 , please select English (LT | EN | RU)). In addition, the macroeconomic criteria subsystem was included.

To choose variables for the Housing Market Crisis Management Model, we also employed the statistical content analysis of publications (bibliometrics). For this analysis all publications available in ScienceDirect, a scientific database, were considered in the investigation (journal papers, books). Our bibliometric analysis (see Table 1) used the term frequency mean based on relevant keywords (in italics) for identifying useful trends in ScienceDirect and Google Scholar. The first part of the table shows the statistical content analysis of publications relevant to the indicator subsystems that define the Housing Market Crisis Management Model in detail. A search by the keyword *housing expenditure* (in X_2, the second criteria subsystem), for instance, returned 774 publications.

The second part of the table, likewise, looks at each indicator in the criteria subsystem X_2 individually. A search by the keywords *housing* + *income* (indicator X_{21} "buyer income"), for instance, returned 56,984 publications, a search by the keywords *housing* + *"real interest rate"* (indicator X_{22} "real interest rate") returned 1,595 publications, and a search by the keywords *housing* + *"nominal interest rate"* (indicator X_{23} "nominal interest rate") returned 936 publications. As we see, the number of publications available in ScienceDirect that mention the indicators from the criteria subsystem of housing expenditure (X_2) was constantly growing between 1997 and 2014 (see Table 1). The same applies to the frequency of keywords from the other criteria subsystems that define the Housing Market Crisis Management Model in detail.

Table 1. Bibliometric analysis of the criteria subsystems and the criteria defining the Housing Market Crisis Management Model

For our search by the keywords *housing*, *prices*, and *incomes* in ScienceDirect, we selected three periods: between 2005 and April 2015 (the search returned 14,936 publications), between 1994 and 2004 (5,960 publications) and between 1823 and 1993 (9,557 publications). Thus we see that the number of publications related to the keywords *housing*, *prices*, and *incomes* has been growing over time. It may be assumed that the criteria subsystem of prices and incomes (X_1) has been becoming more popular in research articles over time (just like the other subsystems from X_2 to X_8).

The system of eight indicator groups is available at http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638 and is used in further calculations of this research/article. If the system's user wishes to take a closer look at any subsystem of the eight indicator groups, he or she can select one of them by clicking *Select objects group*:

The analysis should be done by selecting English (LT | EN | RU). Once a criteria subsystem has been selected, a more in-depth analysis of the global practice for each criterion is available by clicking any criterion. The system also offers recommendations on ways to soften a potential housing market crisis.

The system of criteria for the crisis thermometer consists of the following groups of indicators (see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638):

- Prices and incomes criteria subsystem (X_1)
- Housing expenditure criteria subsystem (X_2)
- Housing supply criteria subsystem (X_3)
- Buyer expectations about prices criteria subsystem (X_4)
- Buyer impatience and financial risk taking criteria subsystem (X_5)
- The credit market criteria subsystem (X_6)
- Speculative behavior criteria subsystem (X_7)
- Macroeconomic criteria subsystem (X_8) housing "Macroeconomic indicator"

The following criteria are discussed as examples to illustrate the aforementioned indicator groups: consumer confidence indicator, Lithuanian annual GDP (X_{81}), inflation rate (X_{83}), index of average real monthly salary per employee, construction input price index (X_{85}), construction works (X_{86}), investments in the construction sector (X_{87}) and housing price index (see Table 2). The criteria under deliberation were calculated for 2007-2013. Our investigation assessed some of the criteria quantitatively (X_{81}, X_{83}, X_{85}, X_{86}, X_{87}, see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638), while others were subjected to conceptual analysis (the consumer confidence indicator, the index of average real monthly salary per employee, the housing price index).

Table 2. Statistical data of indicators under deliberation

The criteria under discussion have various dimensions. Therefore it is quite complex to submit all of them in one chart. Thus, to circumvent such a situation, the criteria under deliberation have been normalized (see Figure 2). The year, when the initial statistical data for the indicator under deliberation (see 1 Table) were greatest, is scored 100%. Meanwhile the other statistical data for the same indicator are recalculated proportionately.

Figure 2. Change trends of relative indicators under discussion, 2007-2013

Figure 2 presents the change trends of the relative indicators under discussion graphed across time. It indicates close relationships between GDP and inflation in Lithuania, index of average real monthly salary per employee in the country, investments in the construction sector and the construction and housing price indexes. As example, a brief analysis of the interrelation of GDP and inflation follows.

GDP and inflation are both considered important economic indicators (What is the... 2014). Inflation affects GDP indirectly. For example, if a change reflects the value of weakening dollars, it, in turn, will affect purchasing power and GDP (How does inflation... 2014). GDP and inflation often associate with one another, because governments and central banks often make decisions based on these figures and additionally they attempt to manipulate them. If an economy is not growing or not growing fast enough, a central bank may lower interest rates to make borrowing more attractive. The logic behind this is that it will encourage spending, which will lead to a rise in GDP (What is the... 2014). The graph presented in Figure 2, showing the ratio of inflation to GDP, allows claiming that:

1. The higher the GDP is, the higher the inflation is. The idea is that an increase in economic growth leads to an increase in inflation — and that decreased growth reduces inflation (Henderson 2007). Both indicators peaked in 2008. The indicators are seen to drop in 2009 but then rise again in 2011.
2. Any country is considered to be on a growth path if, year after year, the percentage of GDP growth is greater than the percentage of inflation; otherwise, inflation is bound to erode the growth (GDP vs. inflation... 2011). Taking this into consideration, it can be claimed that Lithuania grew economically the most during 2010 and 2012; whereas, inflation caused GNP to decrease from 2007-2009 and 2011.

4. Crisis Thermometer: Recommendations for the Housing Market

Language contains many sayings which link our feelings and behavior towards others to temperature. We might, for example, hold “warm feelings” for somebody, and extend them a

“warm welcome”, while giving somebody else “the cold shoulder” or “an icy stare” (The social thermometer).

Temperature can be defined as the degree of hotness or coldness of a body or environment. According to the Free Dictionary, an abnormally high condition of body heat caused by illness is a fever. The more heat material absorbs, the more rapidly the atoms within the material begin moving and thus causes a greater the rise in temperature (Zimmerman 2014). A bursting real estate bubble in an overheated housing market (HS) might be compared to an ill person running a fever of 41°C. Conversely, as the crisis hits and the housing market cools down, it becomes reminiscent of a sick person whose body temperature is too low.

Temperature is a measurement of the average kinetic energy of the molecules in an object or system and can be measured with a thermometer or a calorimeter. It is a means of determining the internal energy contained within a system (Zimmerman 2014). Likewise, a housing market with stored kinetic energy is viable. Here, centigrade (or Celsius), a SI base unit, is employed to measure the temperature of a housing market.

The Crisis Thermometer (CT) provides ratings on a scale in which scores from T_{min}=32.0° to T_{max}=42.0° indicate a cool/overheating housing market.

The formalized presentation of the research shows how changes in the meso and macro environment and the extent to which the goals pursued by various interested parties are met cause corresponding changes in the housing market’s “temperature”.

The authors of this article developed CT to measure the level of a HM crisis. Their basis for the development consisted of the methods, above thermometers, decision support and other intelligent systems in the area for analyzing HM crisis management (see Chapter 1). Furthermore the Housing Market Crisis Management Model developed by these authors and the four decision-making methods (Kaklauskas 1999, 2015), which they had also developed, are included.

CT consists of a data base and a data base management system, models base and models base management system and user interface.

Data base

The process of crisis management in HM involves interested groups, such as clients, developers, users, designers, subcontractors, suppliers, maintenance organizations, municipalities, media (radio, television, newspapers, magazines), banks, *Seimas* parliamentary body, the Government and others whose goals, needs, functions, possibilities and experiences differ. Therefore the viewpoints of such interested groups often do not coincide when making decisions. An objective to achieve comprehensive descriptions of alternatives under discussion often requires their write-ups on the basis of economic, legal, social, technical, technological and other kinds of information (see Figure 1). Such information must be submitted to the user in the most understandable form.

The information needed to make decisions with the Crisis Thermometer (CT) can be submitted in digital, textual or graphic forms (schematics, graphics, diagrams, drawings, drafts) as well as

in formulas, photographs, augmented reality, audio and video and other kinds of forms. For example, the use of information submitted in digital form entails the inclusion of the criteria system, units of measurement, weights and initial criteria values for exhaustive descriptions of presented alternatives. Use of information submitted in textual form entails presenting alternatives and exhaustive written descriptions of conceptual criteria, their reasons and their substantiation by which the weights, meanings and the like of specific criteria are grounded.

This way the CT forms conditions for a decision-maker to receive full-fledged, exhaustive, quantitative and qualitative information about crisis management from data bases that the models base substantiates and permits flexibly by analyzing these factors and making decisions.

An analysis of the applicability of data base structures for similar systems by the type of problem that needs resolution makes it possible to distinguish their levels of effectiveness for use. There are three fundamental data base structures: hierarchical, network and relational. The CT employs the relational data base structure. The information from the relational data base is retained in table form. The data base of the CT consists of the following types of tables:

- Preliminary data tables submit general information about their existing situation and the composite parts of crisis management as well as crisis management goals and their significances.
- Crisis management decision-making tables submitting quantitative and conceptual information on alternative crisis management decisions, including economic, legal, political, managerial, ethical, religious, traditional, educational, social, cultural, psychological and other factors.
- Alternative design tables submit quantitative and conceptual information on the interrelationships, compatibility and possible combinations of the composite parts over the process of their life relevant to HM crisis management and information on its alternatives.
- Crisis management recommendation tables submit quantitative and conceptual information on alternative crisis management recommendations (economic, legal, political, managerial, ethical, religious, traditional, educational, social, cultural, psychological and emotional aspects of crisis management, a quantitative assessment of the beginning of a crisis and current global trends (vicious cycle trends, economic and financial trends, qualitative trends).
- Crisis management alternative designs of recommendations tables submit quantitative and conceptual information on the interrelationships, compatibilities and possible combinations of recommendations and information on designing complexes of alternative recommendations.
- Crisis management recommendations assessment tables submit quantitative and conceptual information on alternative crisis management decisions.

Possible alternatives must be examined in order to design and implement effective crisis management recommendations. It is essential to compile the composite parts of alternative recommendations, as well as their decision-making interrelationships, compatibilities, combinations and alternative design tables to achieve automatic alternative designs. CT can compile numerous alternative variants based on preliminary data, according to the offered method for designing alternatives (Kaklauskas 1999, Lepkova, Kaklauskas, Zavadskas 2008, Kanapeckiene et al. 2010). It is determined whether or not the compiled alternative recommendations conform to the raised requirements. Any alternative that does not conform to

the requirements is no longer considered. The issue of the weight of criteria compatibilities arises, when alternative recommendations are being designed. In the case of assessing alternatives in sets, like the case here, the weight of a specific criterion depends on all the criteria under assessment, their weights and their preliminary meaningfulness.

Models base

Models must be within a CT helping a decision-maker perform a complex analysis of alternatives and make a decision, since the effectiveness of alternative recommendations are often assessed from economic, legal, political, managerial, ethical, religious, traditional, educational, social, cultural, psychological, emotional and other positions,. The models base consists of the following models performing their respective functions in the CT:

- Housing market (HM) crisis management alternatives compiling model
- Preliminary criteria weights establishing model (applying expert assessment methods)
- Criteria weights establishing model
- HM crisis management alternative designing model
- Multicriteria analysis and priority establishing model
- Utility degree establishing model
- HM crisis thermometer model
- Recommendation alternatives compiling model
- Recommendation alternatives designing model
- HM crisis management recommendations submitting model

For example, these models automatically compile variations of HM crisis management recommendation alternatives, perform a multicriteria analysis, establish the utility degree and select the most effective alternatives.

Next, there is a brief description of the Recommender Model to serve as an example. The Recommender Model is user-friendly. Every user is able to access this Recommender Model by launching the link http://iti.vgtu.lt/ilearning/kapateikti.aspx?medid=8 . The Recommender Model provides a question-entry window, where a user chooses a question. The question entry window for a Yes/No question will appear. Depending on the question type, the entry screen provides different options. For example, the multiple choice screen includes space to enter each Yes/No answer choice (see Figure 3). The user's answers are used to generate relevant recommendations (see Figure 4), which are displayed by clicking the "Get advice" button.

Figure 3. Question-entry window

Figure 4. Recommendations for a user

Also, recommendations are submitted in a matrix (see Table 3). The 2007 Housing price to income ratio ($X_{11\ 2007}$=11.3), as an example, can be discussed in Table 3. Worldwide practice indicates that, during a bubble, housing prices would rise much faster than wages existing in the

same geographical and zoning area. Table 3 also shows that, during a bubble (e.g., in 2007 ($X_{11\ 2007}$=11.3) and 2008 ($X_{11\ 2008}$=11.9)), the Housing price to income ratio is greater than it is at any other time (e.g., in 2009 ($X_{11\ 2009}$=9.2) and 2011 ($X_{11\ 2011}$=9)). Calculations show that, assuming the 2007 Housing price to income ratio ($X_{11\ 2007}$=11.3) was the same as it was in 2010 ($X_{11\ 2010}$=8.4), then $X_{11\ 2007}$ would improve by about 25.66% ((11.3 – 8.4) : 11.3 * 100% = 25.66%). If the Housing price to income ratio ($X_{11\ 2007}$) had dropped by 25.66%, then the effectiveness of the 2007 housing market would improve by 0.69%. The housing market would become more attractive, once the Housing price to income ratio (X_{11}) improves.

Table 3. Recommendations submitted in a matrix form

Various models are applicable for use by the models base management system, as suitable for satisfying a user's needs.

Some of the above-listed modules (Criteria weights establishing model, Multicriteria analysis and priority establishing model, Utility degree establishing model and HM crisis management alternative designing model) have been programmed using corresponding methods developed by the authors of this work (Kaklauskas 1999): a method of complex determination of criteria weights considering their quantitative and qualitative characteristics; method of multiple criteria complex, proportional project evaluation; method of defining the utility and market value of an alternative and method of a multiple criteria, multivariant design of a project life cycle. These methods determine the priority, significance (Q_j) and utility degree (N_j) of the compared options. Utility degree (N_j) values are then added to the equations below to determine the "temperature" of the housing market (HM) (T_j):

If a HM tends to be cooling over the year in question, then:

$$T_j = 36.6° + ((100\% - N_j) : 200 \cdot 36.6°).\ j=\overline{1,n}; \quad (1)$$

where T_j is the "temperature" of HM in the j-th year. N_j – the value of the HM utility degree in the j-th year and n - the number of years compared.

If a HM tends to be overheating/forming a bubble over the year in question. then:

$$T_j = 36.6° - ((100\% - N_j) : 200 \cdot 36.6°).\ j=\overline{1,n}. \quad (2)$$

5. Case Study

An analysis of the competitiveness (i.e., "temperature") of the housing market in Lithuania in 2007-2013 was performed on the basis of the above-named, eight quantitative and qualitative criteria sub-systems (see Chapter 3), units of measure, values and weights as well as the data on the years (alternatives) (see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638 , please select English (LT | EN | RU |)).

A competitive market is one in which a large numbers of producers compete with each other to satisfy the wants and needs of a large number of consumers. In a competitive market no single producer, or group of producers, and no single consumer, or group of consumers, can dictate how the market operates. Nor can they individually determine the price of goods and services, and how much will be exchanged (Higson 2011). The "temperature" of the housing market (HM) depends on criteria subsystems at the meso and macro levels.

As an example, a brief analysis appears of a *Macroeconomic HM criteria subsystem* (see Table 4). A country's finances are stable, when the macroeconomic indicators of that country are positive, meaning the country has generated favorable conditions for business. Meanwhile, when a country's financial health is faltering, that country is riskier, meaning conditions are less favorable for business. Gross domestic product (GDP) is one of the most popular economic indicators among economists, investors and policy makers. The other criteria selected for performing the multicriteria analysis of the HM macroeconomic criteria subsystem to assess alternatives were population, inflation rate, unemployment rate, construction input price index in December compared to December of the previous year, construction and investments in the construction sector.

Table 4. Grouped decision making matrix of a macroeconomic multiple criteria analysis

We shall look at "Macroeconomic criteria subsystem" (Table 4, X_8), the eighth of the eight tables of criteria, as an example. This criterion table comprises such key subcriteria/criteria as "Lithuanian annual GDP" (X_{81}, q_{81}=1.5), "Population" (X_{82}, q_{82}=0.2), "Inflation rate" (X_{83}. q_{83}=0.22), "Unemployment rate" (X_{84}. q_{84}=0.12), "Construction input price index in December compared to December of the previous year" (X_{85}, q_{85}=0.79), "Construction works" (X_{86}, q_{86}=0.21) and "Investments in the construction sector" (X_{87}. q_{87}=0.1). A multicriteria analysis of above data (see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638) was performed with the Housing market crisis Thermometer (CT) for analyzing competitiveness in the market. The results of this analysis are presented in Table 5.

Table 5. Multiple criteria, macroeconomic assessment results of the Lithuanian housing market in 2007-2013

The macroeconomic assessment results of the housing market in Lithuania during 2007-2013 (see Table 5) suggest that 2010 is the most competitive ("healthy") year for the Lithuanian HM macroeconomic environment ($Q_{Macro2013}$=0.4898, $N_{Macro2013}$=100%, $T_{Macro2013}$=36.6° [HM macroeconomic "temperature"]).

CT performed the multiple criteria analysis of the competitiveness and "temperature" of HM in Lithuania in 2007-2013 by using the data from Table 4 (plus seven more criteria tables in the CT

website http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638). CT determined the priority, significance (Q_j), utility degree (N_j) and "temperature" (T_j) of each (alternative) year. The higher the Q_j and T_j (significance and utility degree of the year), the more efficient year is for the HM, i.e., it has the higher priority. A generalized/reduced criterion Q_j produced by the CT depends, directly and proportionally, on the relative impact that the values x_{ij} and weights q_i of the compared criteria have on the housing market's "temperature".

It is further important to determine the housing market's "temperature" of each year under analysis. This way a more accurate assessment is made of the positive and negative traits of the year under analysis. A comparison of these traits with the housing market's goals follows along with the establishment of a potential "temperature" for HM.

The "temperature" of the housing market (HM) depends on a number of variables at the meso and macro levels. Readings of the Crisis Thermometer (CT) depend on the influence of many, complex factors (see http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=638 , please select English (LT | EN | RU)). Thus readings taken by CT show whether the housing market is "unhealthy" or "healthy" and they will, therefore, vary depending on the aggregate effect of these meso and macro level factors.

The five indicators – Affordability of housing (number of square meters that can be purchased per average annual salary in Vilnius) (R_1), Housing price index compared to the 2010 index as a base (2010 = 100) (R_2), Lithuanian annual GDP (R_3, X_{81}), Unemployment rate (R_4) and Average real monthly salary per employee in the country's economy compared to the corresponding quarter of the previous year by percentage (R_5) – reflect rather well the general rising or falling trends in HM within a certain period (see Table 6). Here we take a look at these indicators by analyzing three years before and three years after the year in question. The situation with housing affordability in Lithuania, for instance, was better in 2009 (R_{1_2009}=4.8) than in 2006 (R_{1_2006}=2.9), 2007 (R_{1_2007}=3.1) and 2008 (R_{1_2008}=3.8), but worse than in 2010 (R_{1_2010}=5.4), 2011 (R_{1_2011}=5.4) and 2012 (R_{1_2012}=5.7). If each instance of better performance (compared with other years) earns the year a plus (i.e., by taking a specific indicator and seeing the HM situation improving) and poorer performance earns a minus (i.e., by taking a specific indicator and seeing the HM situation getting worse), then R_{1_2009} will score three pluses and three minuses (a rather neutral year). This is because, in terms of housing affordability, Lithuania performed better in 2009 than it did in 2006–2008 but worse than in 2010–2012. Likewise the 2009 Unemployment rate (R_{4_2009}) will appear rather neutral (two pluses and four minuses) compared with the Unemployment rates of the other six years in Lithuania (see Table 6). However, Lithuania's annual GDP performance in 2009 (R_{3_2009}) is below almost all the other years considered in the period from 2006 to 2012. $R_{3\_2009\_0}$ thus earns five minuses and one plus. If we take an integrated look at all these five indicators for 2009, the year, then, scores 11 pluses and 18 minuses in total, which means the trend leans towards a cooling in the housing market (see Table 6).

Table 6. Determining general HM trends

Using the 1st equation, when the aforesaid five indicators earn *more pluses* (see Table 6) than minuses (i.e., this particular year was more successful than unsuccessful for HM), the system determines HM "temperature" T_j of the j-th year:

T_{2007} = 36.6° + ((100% - 87,56%) : 200 · 36.6°) = 38,88°.

The assessment results of the Lithuanian HM in 2007-2013 suggest that 2007 (Q_{2007}=2,1986, N_{2007}=87,56%, T_{2007}=38,88° [see Figure 5]) is the year that was overheating the most (forming the biggest bubble) in Lithuania's housing market.

Figure 5. Lithuanian housing market's "temperature" in 2007 year (T_{2007} = 38,88°)

Using the 2nd equation, where the aforesaid five indicators earn *more minuses* (see Table 6) than pluses (which means the trend leans towards a cooling in HM), the system determines the HM "temperature" T_j of the j-th year:

T_{2009} = 36.6° - ((100% - 76,70%) : 200 · 36.6°) = 32,34°.

The other results of the multiple criteria analysis on the competitiveness ("temperature" [$T_{2007\text{-}2013}$]) of HM in Lithuania in 2007-2013 are as follows:

- 2008: Q_{2008} = 2,183, N_{2008} = 86,94%, T_{2008} = 38,99°
- 2010: Q_{2010} = 2,1156, N_{2010} = 84,25%, T_{2010} = 33,72°
- 2011: Q_{2011} = 2,2602, N_{2011} = 90,01%, T_{2011} = 34,77°
- 2012: Q_{2012} = 2,3369, N_{2012} = 93,06%, T_{2012} = 35,33°
- 2013: Q_{2013} = 2,5111, N_{2013} = 100%, T_{2013} = 36.6°

6. Validation of the Model and Crisis Thermometer for Housing Market Recommendations

The validation of the Housing Market Crisis Management Model and the Crisis Thermometer that was developed on its basis was performed by analyzing whether or not the Crisis Thermometer indicates the "temperature" of Lithuania's housing market sufficiently accurately. The deliberation for this purpose was to determine, if there is a strong, positive linear relationship between "temperature" of the housing market and several of the main indicators of the housing market—the Housing price to income ratio (X_{11}), Buyer income (X_{21}), Construction

works (X_{86}) and Investments in the construction sector (X_{87}). "Temperature" and other indicators of the housing market have various dimensions. Thus, to circumvent such a situation, the indicators under discussion have been normalized (see Figure 6). The year, when the initial statistical data for the indicator under consideration were highest, is scored 100%. Meanwhile the other statistical data for the same indicator are recalculated proportionately.

Figure 6 shows that the "temperature" of a housing market has a strong uphill linear relationship with the following indicators: the Housing price to income ratio (X_{11}, correlation coefficient r_{11} = 0.89813), Buyer income (X_{21}, r_{11} = 0.94025), Construction works (X_{86}, r_{11} = 0.92412) and Investments in the construction sector (X_{87}, r_{11} = 0.95532). These strong, positive, linear relationships validate the reliability of the Housing Market Crisis Management Model and the Crisis Thermometer that was developed on its basis.

Figure 6. Housing market "temperature" calculated by the Model and Crisis Thermometer developed on its basis with the correlation coefficients of several main indicators describing the housing market

7. Conclusions

Different countries frequently select different strategies and tactics in their efforts to lessen the impact of a crisis in the housing market. This is entirely natural, because their economies and housing markets (HM) differ by legal, institutional, technological, technical, cultural, psychological, ethical and other aspects. Traditionally an analysis of a crisis in the HM is grounded on economic, legal, institutional and political aspects. However, HM crisis management in the practice of various countries can be applied more effectively. More attention needs to be paid to social, cultural, ethical, psychological, religious, demographic, spiritual, educational and other qualitative aspects over the course of the existing HM crisis, which until now, have generally not been discussed very much. The authors of this article developed the Housing Market Crisis Management Model and Thermometer to implement such a goal. The Model and Thermometer are briefly described in this article.

In the future we are intended to integrate Crisis Thermometer for Housing Market Recommendations with intelligent decision support systems (Kaklauskas 2015).

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Literature

A Complete Resource for Fast Recovery, 2014. Generalized Anxiety Disorder. Available at: http://www.panic-and-anxiety-attacks.com/generalized-anxiety-disorder/.

Agnello, L., Schuknecht, L., 2011. Booms and busts in housing markets: Determinants and implications. *Journal of Housing Economics*, 20(3), 171-190.

Baumohl, B., 2005. Secrets of Economic Indicators, The: Hidden Clues to Future Economic Trends and Investment Opportunities, 3rd Edition.

Borio, C., Lowe, P., 2002. Asset prices, financial and monetary stability: exploring the nexus. BIS Working Papers, No 114. Monetary and Economic Department, Bank for international settlements. Available at: http://www.bis.org/publ/work114.pdf.

Bosley, C., 2013. Swiss Housing Market Inches Closer to Bubble. Bloomberg. Available at: http://www.bloomberg.com/news/2013-11-07/switzerland-s-housing-market-inches-closer-to-bubble-ubs-says.html

Bunda, I., Ca' Zorzi, M., 2010. Signals from housing and lending booms. *Emerging Markets Review, Elsevier*, 11(1), 1-20, March.

Canada's Housing Bubble, 2013. Canadian Home Price to Income Ratio. Available at: http://canadabubble.com/bubble-defined/bubble-judge/price-income-ratio.html

Canadian Housing Price Charts, 2013. House Price to Income Ratios. Available at: http://www.chpc.biz/history-readings/archives/01-2013

Crowe, C., Dell'Ariccia, G., Igan, D., Rabanal, P., 2013. How to deal with real estate booms: Lessons from country experiences. *Journal of Financial Stability*, 9(3), 300-319

Dreger, C., Kholodilin, K. A., 2011. Speculative Bubble on Housing Markets: Elements of an Early Warning System. DIW Wochenbericht No. 37+38/2011.

Dreger, C., Kholodilin, K. A., 2012. An Early Warning System to Predict the Speculative House Price Bubbles. Economics Discussion Papers, No 2012-44, Kiel Institute for the World Economy.

Federal Reserve Bank of San Francisco, 2003. How is the housing affordability index calculated? Available at: http://www.frbsf.org/education/publications/doctor-econ/2003/december/housing-affordability-index

Free Debt Thermometer, 2014. Available at: http://www.finder.com.au/free-debt-thermometer.

Gil, F., Grassi, L, Travado, L., Tomamichel, M., Gonzalez, J. R., 2005. Use of distress and depression thermometers to measure psychosocial morbidity among southern European cancer patients. *Support Care Cancer*, 13, 600–606.

Goldstein, N. E. S., Serico, J. M., Riggs Romaine, C. L., Zelechoski, A. D., Kalbeitzer, R., Kemp, K., Lane, C., 2013. Development of the Juvenile Justice Anger Management Treatment for Girls. *Cognitive and Behavioral Practice*, 20(2), 171–188.

H o, Y- F., Wang, H-L., Liu C-C., 2012. System Dynamics and Genetic Artificial Neural Network Models for the Monitoring and Early Warning of Urban Housing Market. [Available at: http://www.systemdynamics.org/conferences/2012/proceed/papers/P1234.pdf

Heartland funds, 2012. Positive Developments to Counter Negative News. Available at: http://www.heartlandfunds.com/financial-professionals/Value-Investing-Market-Insight/Shareholder-Letters/Positive-Developments-to-Counter-Negative-News.htm

Heyne, D., King, N. J., Tonge, B. J., Rollings, S., Young, D., Pritchard, M., Ollendick, T. H., 2002. Evaluation of Child Therapy and Caregiver Training in the Treatment of School Refusal. *Journal of the American Academy of Child & Adolescent Psychiatry*, 41(6), 687–695.

Higson, G., 2011. Markets and Market Failures. George Higson and Economics Online, 187.

Hua. Y., 2011. On Early-Warning System for Chinese Real Estate. *International Journal of Marketing Studies*, 3(3).

Huang, Wang., 2005. Translation. A Few women in Melbourne's Chinatown. *Chinese Culture Research 4* (Winter): 152-160.

Hui, E.C.M., Liang, C. The spatial clustering investment behavior in housing markets. Land Use Policy, Volume 42, January 2015, Pages 7-16

Hui, E.C.M., Wang, Z. Price anomalies and effectiveness of macro control policies: Evidence from Chinese housing markets. Land Use Policy, Volume 39, July 2014, Pages 96-109

Hui, E.C.M., Bao, H. The logic behind conflicts in land acquisitions in contemporary China: A framework based upon game theory. Land Use Policy, Volume 30, Issue 1, January 2013, Pages 373-380

Interactive Table, 2009. US department of commerce. Bureau of economic analysis. Available at: http://www.bea.gov/national/.

Introne, J., Iandoli, L., 2014. Improving decision-making performance through argumentation: An argument-based decision support system to compute with evidence. *Decision Support Systems, In Press, Corrected Proof*, Available online 4 May 2014

Jacob, V. S., Marsden, J. R., 1990. A networked expert system framework for economic policy analysis. *Journal of Economic Dynamics and Control*, 14(2), 201-217

Kaklauskas, A., 1999. Multiple criteria decision support of building life cycle: Research report presented for habilitation (DrSc): Technological sciences, civil engineering (02T) / Vilnius Gediminas Technical University. Vilnius: Technika, 119.

Kaklauskas, A. Biometric and Intelligent Decision Making Support. Series: Intelligent Systems Reference Library, Vol. 81. 2015, XII. Springer-Verlag, Berlin, 228 p.

Kaklauskas, A., Zavadskas, E. K. Decision support system for innovation with a special emphasis on pollution. Conference: 2nd WHO international housing and health symposium, September 30 – October 1, 2004, Vilnius, Lithuania. International journal of environment and pollution. 2007, Volume: 30, Issue: 3-4, Pages: 518–528.

Kanapeckiene, L., Kaklauskas, A., Zavadskas, E. K., Seniut, M. Integrated knowledge management model and system for construction projects. Engineering applications of artificial intelligence. 2010, Volume: 23, Issue: 7, Pages: 1200–1215.

Karambelas, D., 2013. New technology developing a thermometer for happiness. Available at: http://www.usatoday.com/story/tech/2013/05/14/technology-pursuing-happiness/2158651/.

Kauko, T., 2012. Neural Networks and Analytic Hierarchy Processes. *International Encyclopedia of Housing and Home*, 103-110

Khalafallah, A., 2008. Neural Network Based Model for Predicting Housing Market Performance, Tsinghua Science and Technology 13(S1), 325-328.

Kolko, J., 2014. Housing Barometer: Recovery Shakes Off Early-Spring Slump. Available at: http://www.trulia.com/trends/category/housing-barometers/

Lepkova, N., Kaklauskas, A., Zavadskas, E. K. Modelling of facilities management alternatives. International journal of environment and pollution. 2008, Volume: 35, Issue: 2-4, Pages: 185–204.

Li, Y., Guo, H., Li, H., Wang, Y., Wang, F., Wang, Z., 2009. Information Systems-based Real Estate Macrocontrol Systems, *International Real Estate Review* 12(2), 171 – 192.

Lind, H., 2008. Price Bubbles on the Housing Market: Concept, theory and indicators. Working Paper No. 58.

Lind, H., 2009. Price bubbles in housing markets: Concept, theory and indicators. *International Journal of Housing Markets and Analysis*, 2(1), 78 – 90.

Lu, C., So, R. W., 2005. Return relationships between listed banks and real estate firms: Evidence from seven Asian economies. *The Journal of Real estate Finance and Economics*, 31(2), 189–206.

Majeske, K. D., Lauer, T. W., 2013. The bank loan approval decision from multiple perspectives. *Expert Systems with Applications*, 40(5), 1591-1598

Mao, Y., Wu, W., 2011. Fuzzy Real Option Evaluation of Real Estate Project Based on Risk Analysis. *Systems Engineering Procedia*, 1, 228-235.

Mattingly, K., Morrissey, J., 2014. Housing and transport expenditure: Sociospatial indicators of affordability in Auckland. *Cities*, 38, 69-83.

Michigan State University, 2014. Creating a Self-Anchored Scale. Available at: https://www.msu.edu/course/sw/850/stocks/pack/slfanch.pdf.

Minsky, H. P., 2008. *Stabilizing an Unstable Economy*. McGraw-Hill Professional.

Mitchell, A. J., Morgan, J. P., Petersen, D., Fabbri, S., Fayard, C., Stoletniy, L., Chiong, J., 2012. Validation of simple visual-analogue thermometer screen for mood complications of cardiovascular disease: The Emotion Thermometers. *Journal of Affective Disorders*, 136(3), 1257–1263.

Morel, D., 2009. Is Australian Residential Property the Last Bubble? Available at: http://www.fusioninvesting.com/2009/05/is-australian-residential-property-the-last-bubble/

Patel, D., Sharpe, L., Thewes, B., Bell, M. L., Clarke, S., 2011. Using the distress thermometer and hospital anxiety and depression scale to screen for psychosocial morbidity in patients diagnosed with colorectal cancer. *Journal of Affective Disorders*, 131(1–3), 412–416.

Ponomarenko, A., 2013. Early warning indicators of asset price boom/bust cycles in emerging markets. *Emerging Markets Review*, 15, 92-106

Richards, A., 2008. Some Observations on the Cost of Housing in Australia. Available at: http://www.rba.gov.au/speeches/2008/sp-so-270308.html

Saad, L., 2007. Gallup Ranks the 2008 Candidates According to a Feeling Thermometer. Available at: http://www.gallup.com/poll/28639/gallup-ranks-2008-candidates-according-feeling-thermometer.aspx

Shekarian, E., Gholizadeh, A. A., 2013. Application of adaptive network based fuzzy inference system method in economic welfare. *Knowledge-Based Systems*, 39, 151-158.

Sichelman, L., 2002. No housing price bubble here. Chicago Tribune. Available at: http://articles.chicagotribune.com/2002-07-14/business/0207140390_1_mortgage-payments-and-income-housing-cycle-barometer-housing-economists

Swanbrow, D., 2001. How America responds. Available at: http://ns.umich.edu/Releases/2001/Oct01/r100901b.html

Treanor, J. J., 2013. 373 - Adenovirus. Cecil y Goldman. Tratado de Medicina Interna (24.ª edición), 2, 2104-2106

Us Residential Real Estate Investment & Business Guide for Foreigners, 2006. Available at: https://books.google.lt/books?id=qF0qAwAAQBAJ&sitesec=buy&hl=lt&source=gbs_vpt_read

Veraguth, T., 2011. How to invest in real estate? UBS Wealth management research.

Xiaoling, L., 2007. Analysis of the current high housing prices in China and possible policies. *Division of Building and Real Estate Economics*, KTH, Stockholm.

Zimmerman, A., 2014. Temperature. Available at: http://physics.about.com/od/glossary/g/temperature.htm.

Table 1. Bibliometric analysis of the criteria subsystems and the criteria defining the Housing Market Crisis Management Model

	ScienceDirect, publications	Google Scholar, results
Bibliometric analysis of the criteria subsystems defining the Housing Market Crisis Management Model		
The criteria subsystem of prices and incomes(X_1) *housing prices incomes*	30,424	423,000
The criteria subsystem of housing expenditure (X_2) *"housing expenditure"*	774	5,560
The criteria subsystem of housing supply (X_3) *"housing supply"*	1,510	26,800
The criteria subsystem of buyer expectations about prices (X_4) *housing buyer expectations prices*	2,650	48,500
The criteria subsystem of buyer impatience and financial risk taking (X_5) *housing buyer impatience financial risk*	49	8,290
The criteria subsystem of the credit market (X_6) *housing "credit market"*	1,655	22,700
The criteria subsystem of speculative behaviour (X_7) *housing speculative behaviour*	3,656	60,200
The subsystem of macroeconomic criteria (X_8) *housing macroeconomic indicator*	3,723	69,500
Bibliometric analysis of the criteria subsystem of housing expenditure (X_2)		
Buyer income (X_{21}) *housing + income* 2014 (4,498), 2013 (3,758), 2012 (3,719), 2011 (2,915), 2010 (2,544), 2009 (2,370), 2008 (2,185), 2007 (1,867), 2006 (1,750), 2005 (1,509), 2004 (1,392), 2003 (1,211), 2002 (1,138), 2001 (1,222), 2000 (1,067), 1999 (941), 1998 (1,044), 1997 (1,023)	56,984	1,730,000
Real interest rate (X_{22}) *housing + "real interest rate"* 2014 (138), 2013 (142), 2012 (91), 2011 (83), 2010 (102), 2009 (50), 2008 (33), 2007 (43), 2006 (42), 2005 (47), 2004 (23), 2003 (26), 2002 (29), 2001 (23), 2000 (39), 1999 (42), 1998 (29), 1997 (44), 1996 (32)	1,595	17,100
Nominal interest rate (X_{23}) *housing + "nominal interest rate"* 2015 (38), 2014 (85), 2013 (97), 2012 (68), 2011 (59), 2010 (56), 2009 (31), 2008 (25), 2007 (20), 2006 (22), 2005 (21), 2004 (17), 2003 (7), 2002 (11), 2001 (6), 2000 (14), 1999 (17) ,1998 (12), 1997 (13), 1996 (15)	936	15,700

Table 2. Statistical data of indicators under deliberation

	2007	2008	2009	2010	2011	2012	2013
Housing price to income ratio (X_{11})	11.3	11.9	9.2	8.4	9	9.2	10.5
Buyer income (X_{21})	1176	1209	1020	1003	1052	1117	1160
The borrowers' credit worthiness (X_{62})	8	8	7	6	6	7	8
Lithuanian annual GDP, billion Litas (1 litas = 3,4528 Euro) (X_{81})	96.138	111.520	92.353	94.625	106.369	113.189	119.575
Construction input price index in December compared to December of the previous year (X_{85})	115.5	100.4	87.4	105.2	100.6	104.1	105.3
Construction works, billion Litas (X_{86})	10.903	12.046	5.942	5.401	6.878	6.724	7.285
Investments in the construction sector, billion Litas (X_{87})	20.312	21.633	12.605	11.257	14.009	14.426	16.434

Table 3. Recommendations submitted in a matrix form

Information pertinent to Housing price to income ratio (X_{11})										
Criteria describing the alternatives	*	Measuring units	Weight	Years under analysis						
				2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Housing price to income ratio	-	Index	0.42	11.3	11.9	9.2	8.4	9	9.2	10.5
Possible improvement of the analysed criterion in %				(25.66%)	(29.41%)	(8.7%)	(0%)	(6.67%)	(8.7%)	(20%)
The housing market would become more attractive in %				0,69%	0,79%	0,23%	(0%)	0,18%	0,23%	0,54%

*- The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Table 4. Grouped decision making matrix of a macroeconomic multiple criteria analysis in Lithuania, 2007-2013

Criteria describing the alternatives	*	Measuring units	Weight	Compared years						
				2007	2008	2009	2010	2011	2012	2013
Lithuanian annual GDP, X_{81}	+	Million Lt	1.5	96138	111520	92353	94625	106369	113189	119575
Population, X_{82}	+	Units	0.2	3249983	3212605	3183856	3141976	3052588	3003641	2971905
Inflation rate, X_{83}	-	Percent	0.22	5.8	11.1	4.2	1.2	4.1	3.2	1.9
Unemployment rate, X_{84}	-	Percent	0.12	4.3	5.8	13.7	17.8	15.3	13.2	12.2
Construction input price index in December, X_{85}	-	Percent	0.79	115.5	100.4	87.4	105.2	100.6	104.1	105.3
Construction works, X_{86}	+	Million Lt	0.21	10903	12046	5942	5401	6878	6724	7285
Investments in the construction sector, X_{87}	+	Million Lt	0.1	20312	21633	12605	11257	14009	14426	16434

*- The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Table 5. Multiple criteria, macroeconomic assessment results of the Lithuanian housing market in 2007-2013

Criteria describing the alternatives	*	Measuring units	Weight	Compared years						
				2007	2008	2009	2010	2011	2012	2013
Lithuanian annual GDP, X_{81}	+	Million Lt	1.5	0.1965	0.228	0.1888	0.1934	0.2174	0.2314	0.2444
Population, X_{82}	+	Units	0.2	0.0298	0.0295	0.0292	0.0288	0.028	0.0275	0.0272
Inflation rate, X_{83}	-	Percent	0.22	0.0405	0.0775	0.0293	0.0084	0.0286	0.0223	0.0133
Unemployment rate, X_{84}	-	Percent	0.12	0.0063	0.0085	0.02	0.026	0.0223	0.0192	0.0178
Construction input price index, X_{85}	-	Percent	0.79	0.127	0.1104	0.0961	0.1157	0.1106	0.1145	0.1158
Construction works, X_{86}	+	Million Lt	0.21	0.0415	0.0458	0.0226	0.0206	0.0262	0.0256	0.0277
Investments in the construction sector, X_{87}	+	Million Lt	0.1	0.0184	0.0195	0.0114	0.0102	0.0127	0.013	0.0148
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0.2862	0.3228	0.252	0.253	0.2843	0.2975	0.3141
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0.1738	0.1964	0.1454	0.1501	0.1615	0.156	0.1469
Significance of the alternative				0.4347	0.4542	0.4295	0.4249	0.4441	0.4629	0.4898
Priority of the alternative				5	3	6	7	4	2	
Utility degree of the alternative, %				88.75%	92.74%	87.69%	86.76%	90.67%	94.52%	100%

*- The sign "+/-" indicates that a greater (less) criterion value corresponds to a greater significance for a user (stakeholders)

Table 6. Determining general HM trends

Criteria describing the alternatives	*	Measuring units	Compared years						
			2006	2007	2008	**2009**	2010	2011	2012
1.Affordability of housing (number of square meters that can be purchased per average annual salary in Vilnius) (R_1) (neutral year in 2009)	+	Square meters	2.9 (-)	3.1 (-)	3.8 (-)	**4.8 3(+) 3(-)**	5.4 (+)	5.4 (+)	5.7 (+)
2.Housing price index compared to the 2010 index as a base (2010 = 100 [R_2]) – four years more successful and one year less successful (rather successful year in 2009)	-	Index	112.5 (-)	142.5 (-)	155 (-)	**110 4(+) 1(-)**	100 (+)	110 0	114 (-)
3.Lithuanian annual GDP (R_3) (the worst situation was in 2009)	+	Milliard Euro	23.7 (-)	27.8 (+)	32.3 (+)	**26.7 1(+) 5(-)**	27.4 (+)	30.8 (+)	32.8 (+)
4. Unemployment rate (R_4)	-	Percent	5.6 (+)	4.3 (+)	5.8 (+)	**13.7 2(+) 4(-)**	17.8 (-)	15.3 (-)	13.2 (+)
5. Average real monthly salary per employee in the country's economy, compared to the corresponding quarter of the previous year, by percentage (R_5) (the worst situation was in 2009)	+	Percent	111.4 (+)	116.3 (+)	110.3 (+)	**92.8 1(+) 5(-)**	95.1 (+)	91 (-)	99.3 (+)
Determining general CRE trends in 2009						**11(+) 18(-)**			

Figure(s)

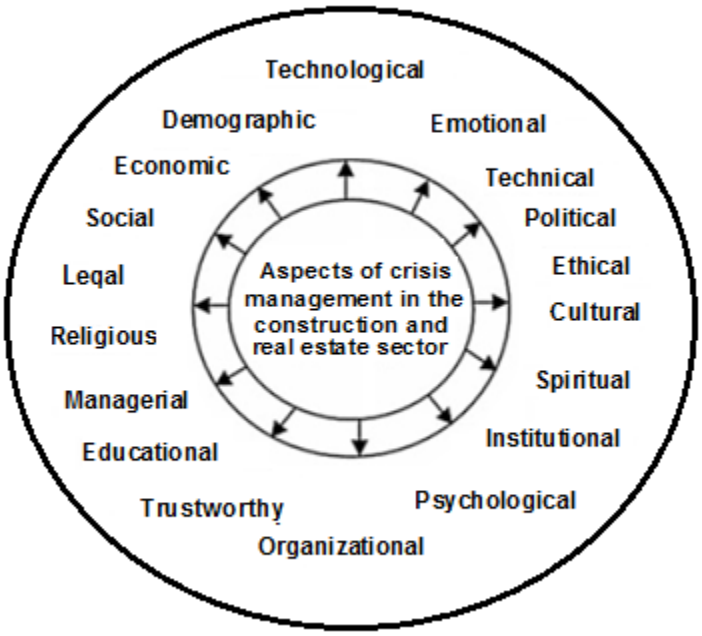


Figure 1. Aspects of crisis management in the construction and real estate sector

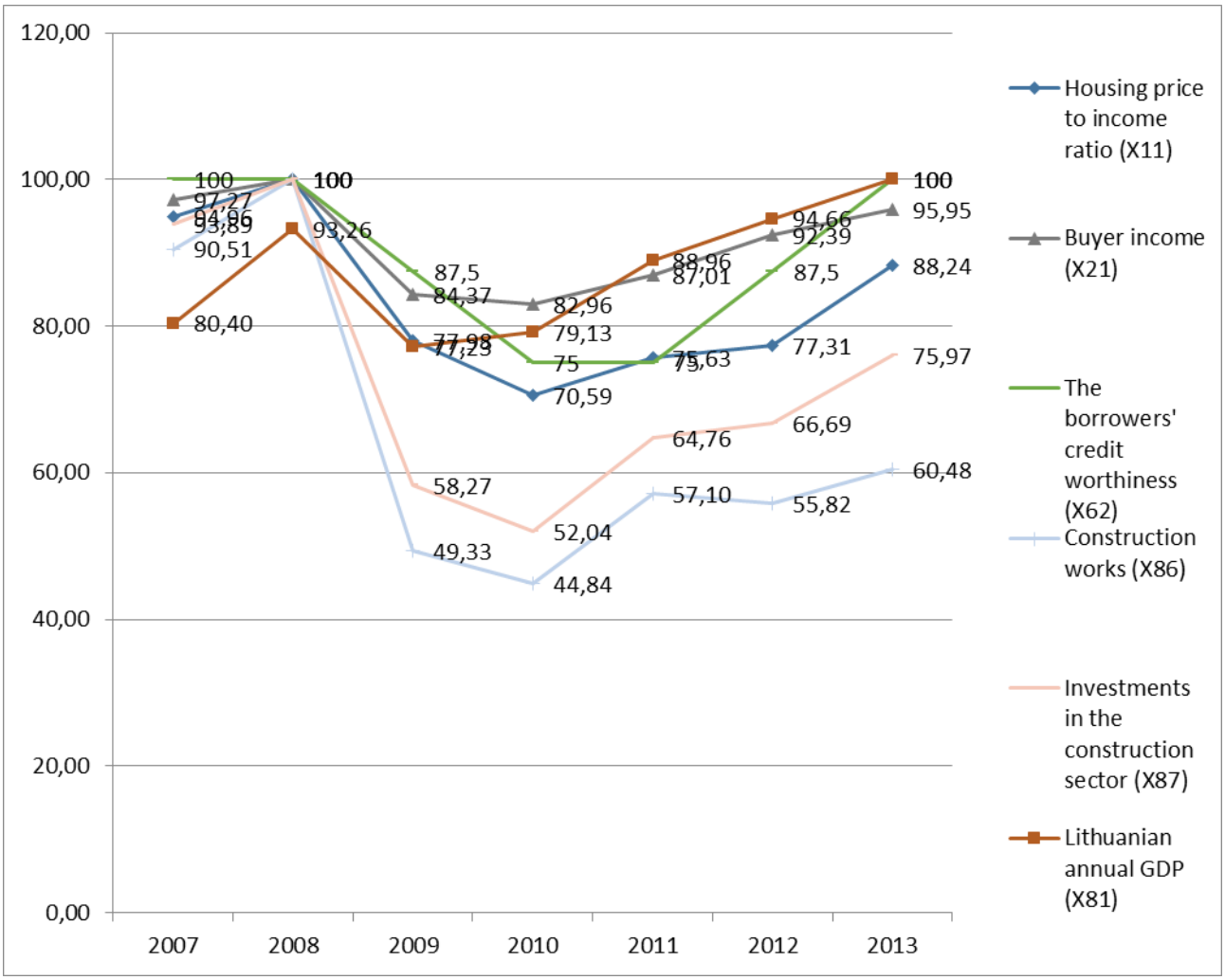


Figure 2. Change trends of relative indicators under discussion, 2007-2013

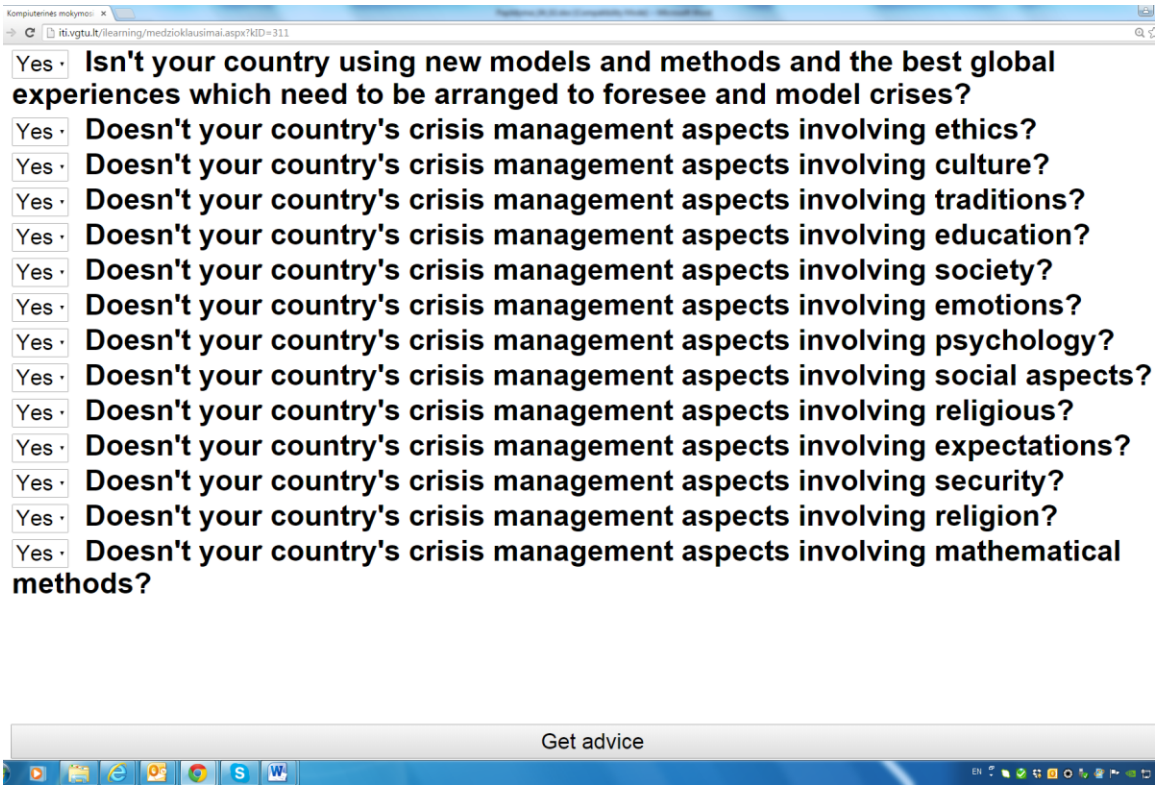


Figure 3. Question-entry window

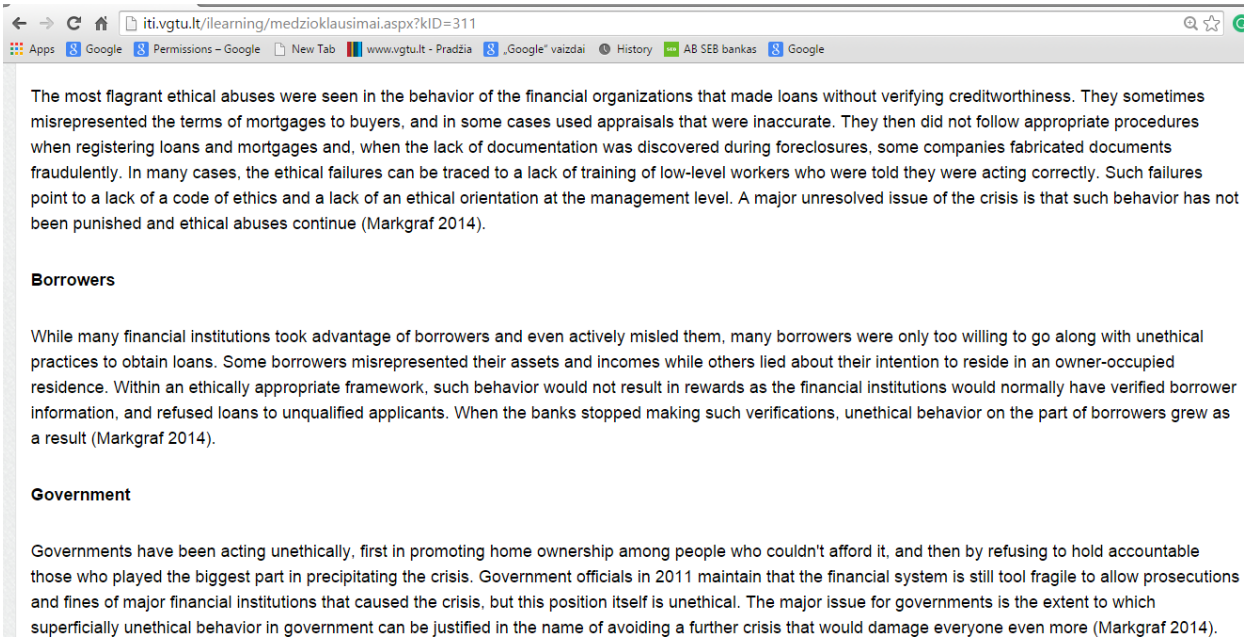
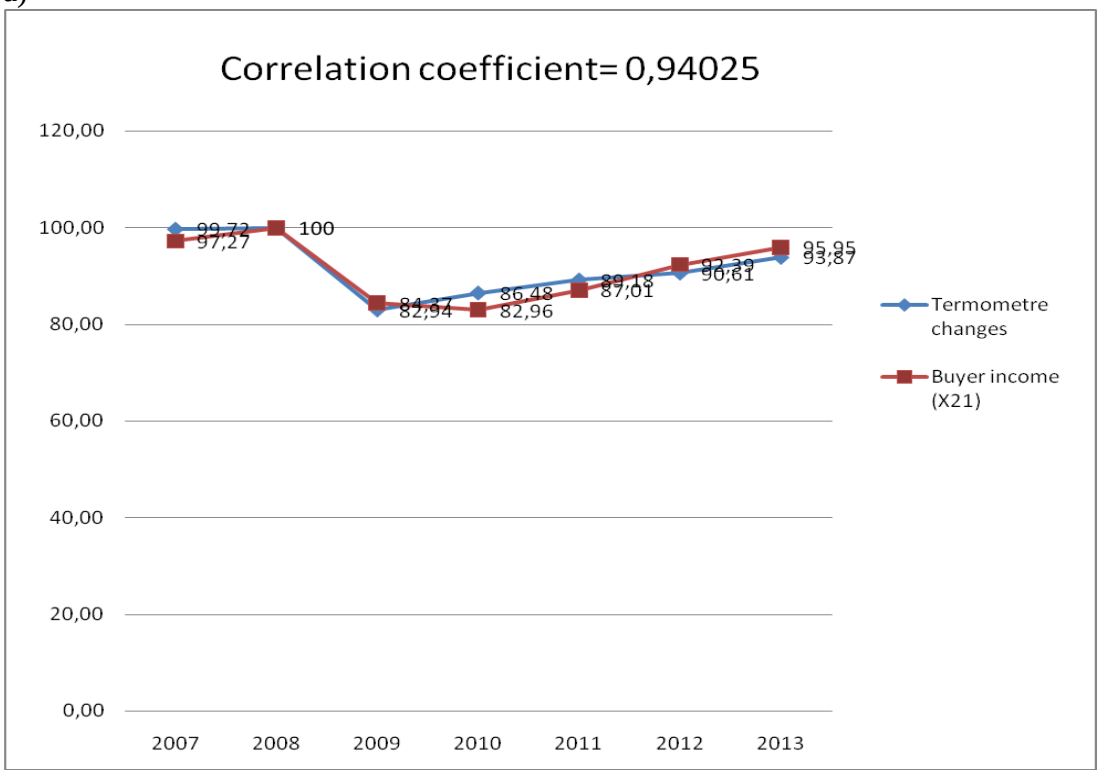


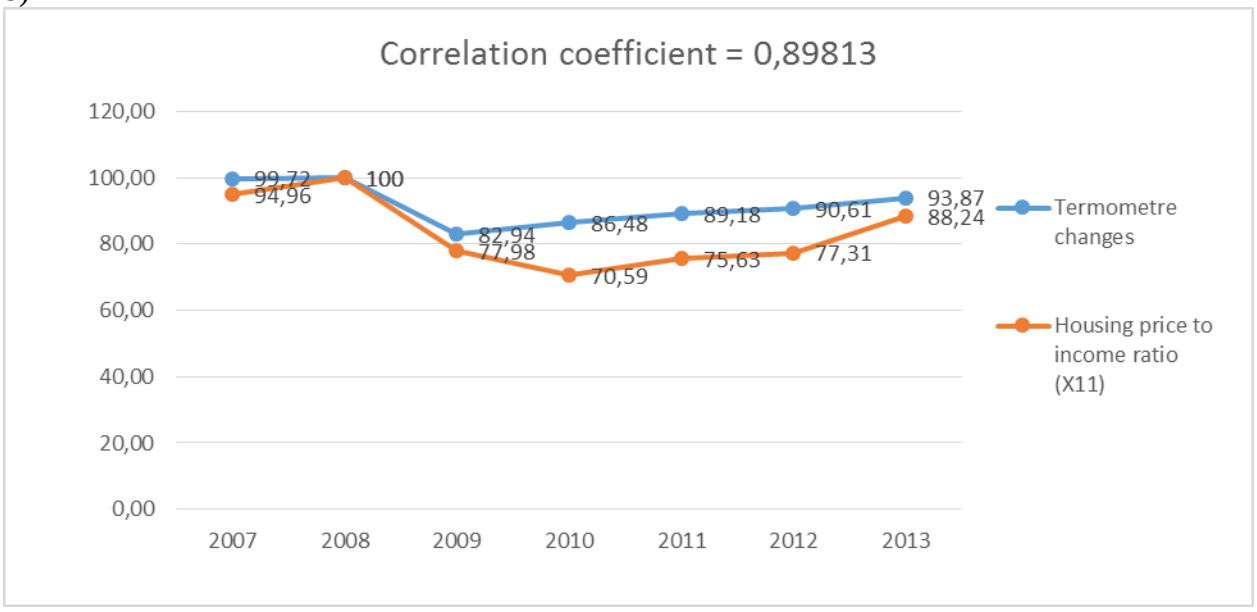
Figure 4. Recommendations for a user

Figure 5. Lithuanian construction and real estate industry's "temperature" in 2007 year (T_{2007} = 38,88°)

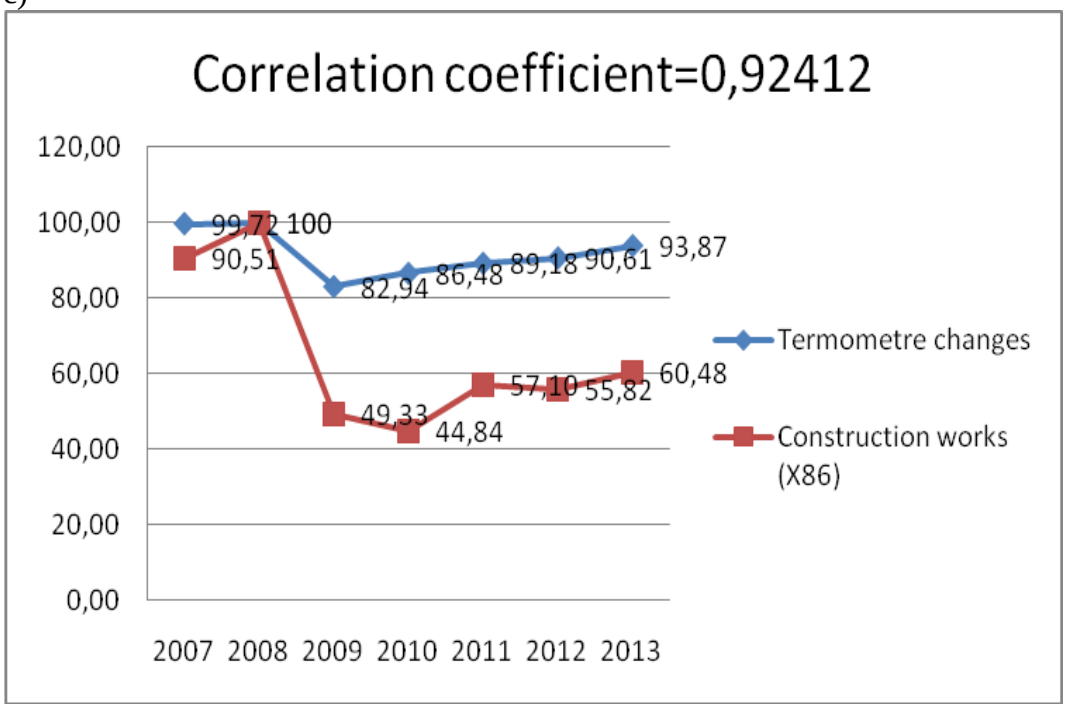
a)


Correlation coefficient= 0,94025
120,00
100,00
80,00
60,00
40,00
20,00
0,00
2007
2008
2009
2010
2011
2012
2013
99,72
97,27
100
84,37
82,94
86,48
82,96
89,18
87,01
92,39
90,61
95,95
93,87
Termometre changes
Buyer income (X21)

b)


Correlation coefficient = 0,89813
120,00
100,00
80,00
60,00
40,00
20,00
0,00
2007
2008
2009
2010
2011
2012
2013
99,72
94,96
100
82,94
77,98
86,48
70,59
89,18
75,63
90,61
77,31
93,87
88,24
Termometre changes
Housing price to income ratio (X11)

c)



d)

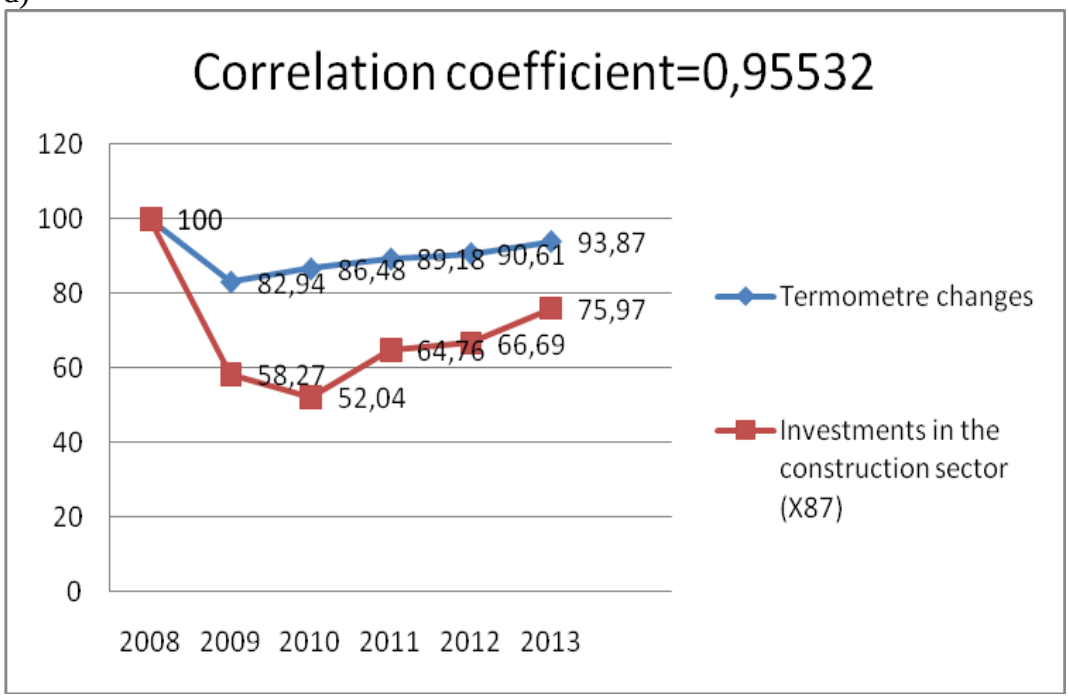


Figure 6. Housing market "temperature" calculated by the Model and Crisis Thermometer developed on its basis with the correlation coefficients of several main indicators describing the housing market