THESIS ON CIVIL ENGINEERING F50

Comparison of Housing Market Sustainability in European Countries Based on Multiple Criteria Assessment

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Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any academic degree.

/Tiina Nuuter/

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Hulgikriteeriumide simultaananalüüsi mudel eluasemeturu jätkusuutlikkuse hindamiseks

TIINA NUUTER

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KIRJASTUS

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List of Abbreviations

AHP	– Analytic Hierarchy Process
ARAS	– Additional Ratio Assessment
ARCH	– Autoregressive Conditional Heteroskedasticy
ARMA	– Autoregressive Moving Average
BPI	– Building Price Index
COPRAS	– Multiple Criteria Proportional Assessment
CPI	– Consumer Price Index
CVAR	– Cointegrated Vector Autoregression
DSGE	– Dynamic Stochastic General Equilibrium models
DSS-HS	– Decision Support System for Housing Sustainability Assessment
EKHHL	– Association of Estonian Facilities Administrators and Maintainers
EVAMIX	– Evaluation of Mixed Data
FOA	– Flat Owners Association
GARCH	– Generalized Autoregressive Conditional Heteroskedasticy
GDP	– Gross Domestic Product
HAI	– Housing Affordability Index
HCI	– Housing Cost Index
HPI	– Housing Price Index
LI	– Loan-to-Income ratio
MLI	– Mortgage Loan Index
MCAM	– Multiple Criteria Assessment Model
MCDM	– Multiple Criteria Decision Model
PPS	– Purchasing Power Standard
SAW	– Simple Additive Weighting
SEMPRE	– Sustainability Evaluation Metric for Policy Recommendations
SHIFT	– Sustainable Housing Indicators using Fuzzy-set Theory
TOPSIS	– Technique for Order Preference by Similarity to an Ideal Solution;
VECM	– Vector Error Correction Model
VIKOR	– VIšekriterijumsko KOmpromisno Rangiranje

List of Symbols

a_j – j^{th} alternative;

x_{ij} – attribute value of the j^{th} alternative;

m – number of attributes;

n – number of alternatives;

$\hat{x}_{ij}$ – sum of dimensionless weighted index values

N_j – utility degree of the j^{th} alternative (COPRAS method);

P – initial decision-making matrix;

$\overline{P}$ – normalised decision-making matrix;

$\hat{P}$ – normalised weighted decision-making matrix;

q_i – significance (weight) of the i^{th} criterion;

Q_j – efficiency index of the j^{th} alternative (COPRAS method);

r – rank;

S_{+j} – sum of maximizing attributes (COPRAS method);

S_{-j} – sum of minimizing attributes (COPRAS method);

$S_{-\min}$ – minimal sum of minimizing attributes (COPRAS method);

1. Introduction

1.1 Background

Housing as a starting point is important for every area of human activity and relates also to environmental aspects. Housing issues could be viewed through five paradigms: housing as a human right, housing as an economic good, housing as home, housing as a means to provide social order and housing as one of numerous competing land uses. Housing as a human right means that adequate, safe, and affordable housing is critical to proper human development. Housing as an economic good means that substantial capital gains and losses occur regularly, as housing is mostly financed and provided, by private development. Housing as a home means rights, privacy, safety and freedom. This includes access to and tenure in safe, decent housing for all people *(Iglesias, 2012)*.

Along with these main paradigms, housing provides social order and is one of numerous competing land uses. These two paradigms imply the importance of social planning policies. The dominance of the paradigm of housing as an economic good has led to widespread privatisation of housing in post-socialist transition economies.

Housing as a home has different concepts in Western Europe and the United States. Globalisation and the gender revolution occurred on both continents, but in Western Europe, native-born residents view home as a haven – a secure, predictable, private retreat around public identity and cultural background, whereas in the United States, residents desire home as a haven from the demands of the workplace and fast-paced society. Though disappointment arises more from social status, Europeans feel more disappointed and insecure *(Keller, 2012)*.

A lot of attention is focused on tenure forms: "As on the macro level, the policy theory of market correctives means that political decisions on tenure forms are crucial. The dominant policy theory says it is not for the state to decide how citizens should be housed, but it may be for the state to set up guarantees that citizens have a real opportunity to find decent housing in the market at a reasonable cost. This is why housing tenures should be seen as the most important political instruments of housing provision as welfare state policy" *(Bengtsson, 2012)*. Ways to defend and support individual renters may also be found in Wyly's statements *(Wyly, 2013)*. Different housing options and their attractiveness reflect what households want to consume. Actual consumption depends on household budget, financing limitations, housing market conditions and governmental incentives *(Drew and Herbert, 2013)*. It is evident that there are and will remain potential conflicts between macro housing objectives and social objectives, at least in times of increasing income differentials, so it is extremely important to understand what the share of the financially vulnerable households is. For those, housing as a human right also includes the freedom to choose the form of tenure.

The housing market is a crucial part of a country's well-being. From one side, macroeconomic development gives rise to the housing market and continuous demand for housing units and corresponding construction activities are key factors for economic prosperity. Unfortunately this economic development may mostly be financed through credit and any downturn in the country's economy then leads to insolvency. So far, in market economies, markets have a cyclical nature.

Housing is most likely to change in times of significant social, political, or economic transitions. In the process of transition to a market economy, the Estonian authorities decided to privatise the existing public rental housing stock in the hope that private home ownership would be the best way to maintain the rather old and shabby housing stock and, on the other hand, to redistribute housing wealth. This decision was supported by the EU Housing Policy Guidelines and world-wide housing policy trend to increase home ownership *(Housing_Policy_Guidelines, 1993, Jowsey, 2011, Levitin and Wachter, 2013)*.

As it turned out, the outcomes of this policy were negative, bad loans led to financial collapse and the bubble that resulted in the 2007 credit crunch was significant not only for its size but also for its nature. I totally agree with Lawson, who found that "this was an over-lending induced crisis" *(Lawson, 2009)*.

The tenure split of the EU27 members reveal that Eastern European countries Estonia, Romania and Bulgaria lead the owner-occupancy rate, which reaches almost a hundred percent. In Lithuania and Slovenia, the proportion of owner-occupiers is about ninety percent. Unfortunately, the high home ownership rate in these countries is accompanied by a high rate of housing deprivation – corresponding to 28,6% and 28,8% in Romania and Bulgaria, 12,2% in Estonia, 16,8% in Lithuania and 17,5% in Slovenia *(CECODHAS, 2011)*.

Naturally some questions arise. Why is the EU home ownership rate 60%? And why, despite of all the efforts to increase home ownership in the UK and US, are the rates in these countries with their mature housing markets still below 70% *(Brett and Schmitz, 2009, Brissimis and Vlassopoulos, 2009, CECODHAS, 2011)*? Though the situation where the increase in home ownership exceeded the natural market rate became a world-wide trend *(Kaklauskas et al., 2011)*, the home ownership rate seemed to be stabilising *(Hulse and Haffner, 2014)*.

1.2 Research Methods and Strategy

Housing is an extremely important and complex area with its mutual dependence on macro-, meso- and microeconomics and the physical, built and social environment. Consequently, a holistic view of housing comprises economic, social and environmental criteria.

There are also many stakeholders in housing whose interests might be in conflict or who have no long term vision about sustainable housing development. Sustainability assessment includes multiple criteria and, to overcome possible misinterpretations, economic, social and environmental criteria should be

included while stressing the economic point of view. This is important for the countries in transition but might also be useful for Western Europe.

The research methodology is based on the analysis of publications in the field of housing. Expert analysis, multiple criteria analysis, comparative analysis, logic and synthesis methods are applied in the performed research.

The preparation of the dissertation was based on scientific publications, encyclopaedia directories, specialized directories, statistical publications, the online statistical data of various countries and other scientific and informational publications of Estonian and foreign scientific institutions.

1.3 Purpose

The aim of the dissertation is to:

- assess and compare the sustainability of housing markets in selected European countries;
- create a multiple criteria model and decision support system for housing which enables recommendations for improving the housing situation to be given depending on the initial data; and,
- give insights into the development of the Estonian housing market which has excessive home ownership and insufficient access to affordable housing for certain income groups.

1.4 Focus and Scope of the Research

Though there are *pros* and *cons* of home ownership, unpleasant results from an increase in home ownership dominate as households tend to achieve higher social status through home ownership at any cost and, at the same time, there will always be a part of society which is not able to acquire a home. The following questions need to be answered:

- is a housing market with a high owner-occupancy rate sustainable?
- how affordable is owner-occupied housing to everyone?
- what is the rate of owner-occupation that is consistent with the economy's underlying growth path?
- which other problems are evident in countries with high home ownership rates?

1.5 Contribution of the Dissertation

A unique MCAM - Multiple Criteria Assessment Model and DSS-HS - Decision Support System for Housing Sustainability was elaborated and tested.

A system of criteria (general economic, housing stock, housing quality, housing sustainability, social and environmental) for comparative assessment of housing markets was proposed.

The assessment elaborated in this research revealed that there is an urgent need to improve the sustainability of the Estonian housing market (as well as those of other Baltic States).

The elaborated DSS-HS - Decision Support System for Housing Sustainability Assessment proved to be a valuable tool to compare housing markets and assess their sustainability.

The system created allows the ranking of all the regions according to the sustainability of the housing market with the precondition that the availability of statistical data will be improved.

Diversity of income and, correspondingly, of the housing stock, does not always guarantee social order and massive developments in the outskirts of cities may not be the best land use. The results confirmed that, from a social point of view, social housing and affordable rental units are the only way to assist residents with lower social status.

The most important issue for real estate and construction market analysis and for reliable research results is to create a data collection system for construction cost.

1.6 Outline of the Dissertation

The dissertation consists of an Introduction, 4 Sections, Conclusions, 4 Annexes, References, List of Publications and Curriculum Vitae.

The outline of the dissertation is presented in Figure 1.1.

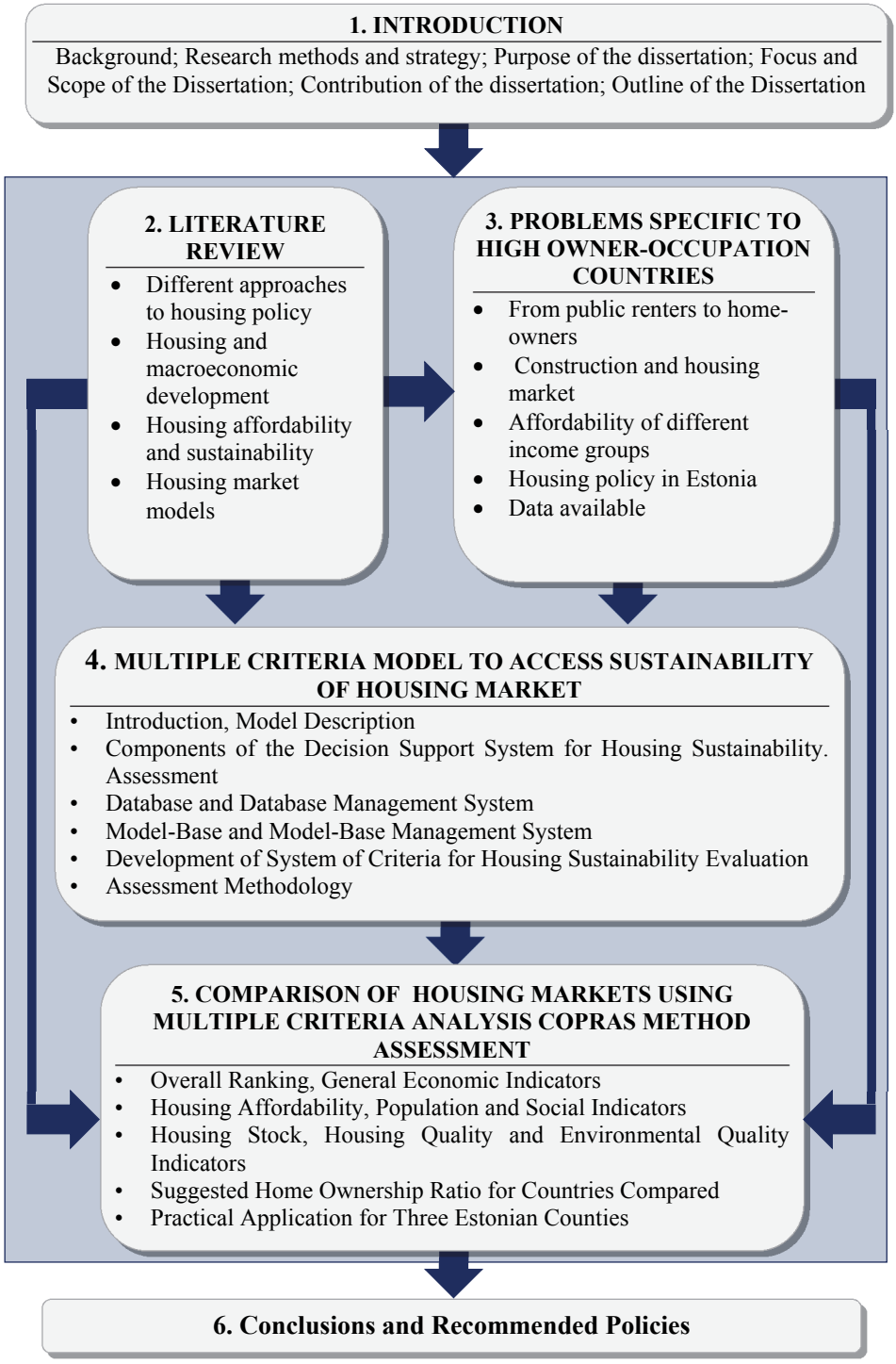


Figure 1.1 The outline of the dissertation

2. Literature Review

2.1 Different Approaches to Housing Policy

This section gives some insight to the development of housing policy in Europe and US. Although Cullingworth's statement: "Policies are the cultural products of history, time and place: they are rarely exportable", cited by Oxley is commonly accepted, *(Oxley, 2011)* prevailing policies of increasing the home ownership were easily imported to the Baltic States.

Though it is questionable whether research should protect the public interest or help authorities to solve economic problems including housing, the following review shows multiple findings sometimes similar, sometimes at odds. Housing is indeed a complex commodity – as an asset, having investment and consumption dimensions *(O'Sullivan, 2003, O`Sullivan and Gibb, 2003)*.

After the Second World War policies were concentrated to reducing housing shortages including social housing programmes. Much research was carried out in the UK, Sweden and other countries *(Gustafsson et al., 1980, Harsman, 1981, Hårsman and Lenntrop, 1984, Smith et al., 1988)*. The policies were aimed at landlords in the form of subsidies, tax allowances and favourable credit conditions.

A comprehensive overview of urban policy in the Nordic countries has been conducted by Hamburger, 2004, as in the Nordic countries urban policy is seen as a part of welfare policy *(Hamburger, 2004)*.

Policy goals for Denmark are that good and sound homes shall be ensured for all citizens by providing a broad and varied supply of housing that gives all population groups the opportunity to find a home suited to their needs and financial resources *(Baunkjær, 2004)*.

Finland aims that all population groups shall be able to have access to a home at a reasonable cost, a home of size and standard that meets specific criteria and that is located in a good and functional housing environment.

Swedish policy is to supply the whole of the population with sound, well-designed and well-equipped homes of good quality at affordable costs.

In Sweden all housing production, including owner-occupied homes and private rented housing, have been given almost equivalent state assistance. There is no separate social rented housing sector in Sweden. The rented sector is municipally owned by non-profit companies and the private rental sector. In 2000, the share of public and social rented sector was 20% in Denmark, 15% in Finland and 23 % of the housing stock in Sweden *(Hamburger, 2004, Karlberg and Victorin, 2004)*.

Institutional arrangements and housing subsidy systems differ, but the governments of all EU countries influence the provision of housing, even in times of strict public expenditure constraints. No country has a free-market approach where individuals determine the demand and supply of housing relying

on a general increase in household incomes *(Oxley, 2011)*. Still, the magnitude and essence of the public influence differs.

Common arguments in favour of home ownership are lower maintenance costs, possible capital gains and higher prestige. This is true if homeowners have no repayment burden and if the location and quality of the housing units are consistent with market price movements. In this sense, development projects on the outskirts of larger towns are not the best examples.

Arguments in favour of rental housing are mobility, reduced responsibility of tenants for the maintenance and less costly movement to another location or apartment. Tenants can also respond to the change of their income flows by moving into smaller housing units. One of the advantages of a rented home is that residents can rent one thanks to rent allowances *(Priemus, 2012)*.

Though incomes and prices determine the tenure choice, an important issue is value orientation. The importance of value orientation was confirmed by findings in the Netherlands where two groups of residents were investigated – those that strive for self-direction values and those who find security values most important. The groups did not differ with regard to age, gender or income, still both renting and home ownership attracted both value types, although for different motivational reasons *(Jansen, 2014)*. Also in Germany, cultural norms have supported the idea of making a home in private rented housing *(Hulse and Haffner, 2014)*.

Usually house price variations influence the choice between renting and buying and the strategic decision to buy as an investment. Emerging markets are extremely inefficient and buyers continue to purchase houses regardless of their rising price *(Tsai, 2013)*. An important reason why increased access to credit and the impact of house prices matters for macroeconomic stability and the stability of the financial system is that house prices can overshoot their fundamentals. The empirical evidence is that housing markets are not "efficient" in industrial countries too.

Buying as an investment reduces the purchasing power of people in lower income classes and forces prices upwards.

Most economists agree that the price of owner-occupied housing is not subject to any direct controls and thus, in an elementary sense, price is a function of the level of demand and the level of supply.

On a macro level, the most powerful policies to introduce are fiscal and monetary policies which affect the construction industry including housing. The interrelations were illustratively presented by Kaklauskas who classified the construction environment into macro, meso- and micro environments *(Kaklauskas et al., 2011)*.

As economics is about choices, different agents may have objectives, usually aimed to improve things. Policy makers have relied on various schools of economic research.

Oxley classifies economic research into the neoclassical approach which dominated in the late nineteenth and twentieth century and concentrated attention to individual well-being and profit maximization. There were sub-schools emphasizing utility or equilibrium. The reductionist approach emphasized the complications of the real world. Modern institutional economists stress the role of information and transaction costs. He concludes that, despite shortcomings of neoclassical economics and the advances in modern economics, it has considerable influence on so-called „Mainstream economics" *(Oxley, 2011)*.

Whitehead in turn argues that the neoclassical tradition with its emphasis on a perfect market has, over the last decades, turned into a more politicised concept of neoliberalism focusing on the free market and a massive reduction in government intervention *(Whitehead, 2012)*. These policies caused the expansion of financial markets and the global financial crisis.

The neoliberal approach influenced the policy of privatisation both in Eastern and Western Europe. The results of privatisation are desirable to those who were able to purchase, but it created a greater concentration of poverty. Difficulties of access and affordability for new entrants to the owner-occupied market increased during the 21st century *(Whitehead, 2012)* .

Behavioural economists suggest that very significant imperfections arising from overconfidence, lack of information and other human errors, make the prediction of the market unsafe *(Frank and Bernanke, 2008, Whitehead, 2012)*. Results of Miles' research indicate that uncertainty has a negative impact on housing starts *(Miles, 2009)*. Research in Estonia revealed that financial behaviour of households is not based on economic factors, such as changes in income or a phase of life-cycle *(Ahmet, 2010)*. Housing demand is indeed greatly based on expectations, which in turn gives way to human errors. Especially in the countries of transition, as they have not experienced the cyclical nature of a market economy, buyers continue to purchase houses regardless of their rising price *(Tsai, 2013)*. Even in the US, after recession demand did not respond to failure *(Drew and Herbert, 2013)*.

In 2013, Levitin and Wachter argued that, for years, the overall housing policy in the US targeted an increase of home ownership, conveniently concealing the lack of coordination of housing policy and finance. Now it is not clear if it should be focused on maximizing home ownership, maintaining home ownership at a particular level or facilitating rental stock *(Levitin and Wachter, 2013)*. Their arguments are supported by Wyly who finds that neoliberalization pushes working-class and middle-class households to struggle into home ownership while borrowing to the limit to buy as much real estate as possible *(Wyly, 2013)*.

Among other advocates of home ownership, Gyourko suggested that relaxing down-payment constraints via lower interest rates, not policies of payment-to-income requirements, will increase affordability of owner-occupied housing *(Gyourko, 2008)*.

Policies to increase home ownership lead to indebtedness and housing deprivation. According to Scanlon *et al*. policies to encourage mortgage lenders were general macroeconomic policies increasing the money supply and reducing interest rates, but in 2009 policy turned to assisting borrowers in payment difficulties. These policies included a reduction in interest rates, temporary government assistance with mortgage payment for the unemployed, freezing payments, changing the terms of loans, etc. *(Scanlon et al., 2011)*. Chambers *et al*. presented an overview of the historical path of housing policies in the US which were mainly aimed at regulating housing finance and the tax treatment of owner-occupiers. The main conclusions were that government intervention via the mortgage markets (prolongation of the length of the loan to 30 years) was a key part of the housing boom *(Chambers et al., 2012)*. Evidently, the results of these policies are unclear. Scanlon *et al.* referred to behavioural economists who suggest that consumers are not rational but risk-takers and there always remains the question, who really qualifies for government assistance?

Wickens recommends limited intervention which should target the specific goals of preventing speculative bubbles, regional price stabilisation and protecting vulnerable borrowers. Among other things, he recommends the introduction of loan to value ratios and income to price ratios to help borrowers understand the risk they face in the housing market *(Wickens, 2010)*. Still, Walker argues that highly optimistic opinions about house prices explain the US housing boom better than the common explanation of cheaper and easier credit *(Walker, 2014)*.

Along with tenure split, housing policy is concerned with housing assistance. Subsidies can be classified in the manner in which they are provided, whether they are targeted to housing consumers or producers, to renters or owners. Yates divides government assistance into market–supplementing and market-supporting actions *(Yates, 2012)*. Multiple approaches are reasoned by multiple reasons why government intervenes in the housing market.

From the demand-side, governments might try to increase incomes by using some sort of income supplement, subsidizing consumption of housing, making credit cheaper and available, introducing tax allowances for interest payments or a combination of these policies.

Supply-side approaches involve subsidies, which are usually given with conditions. In Germany, social housing subsidies have been available to a variety of private and public-sector landlords. In the UK, subsidies have gone to support local authority housing and thus large municipal landlords have been the main suppliers of social housing. Still, in 1990 there was a strong shift from social housing construction to housing allowances. This move away from supporting the supply towards supporting the demand was most visible in the UK *(Lux, 2003)*.

In Greece and Spain, social housing subsidies have supported owner-occupation, not social renting *(Oxley, 2011)*.

General housing allowances and allowances to retired people are introduced in Finland and Sweden. In Denmark, housing allowances are received by families with children and retired residents. The total number of households receiving housing allowances as a percentage of all households by form of tenure in 2002 was: rented housing in Denmark 49%, in Finland 54% and Sweden 31% *(Åhrén, 2004)*.

Galster compared demand- and supply-side approaches and concluded that, though neither of them represents pre-eminent means for attaining goals, the demand – side approach has the comparative advantage of covering a wider range of goals *(Galster, 1997)*. The latest research revealed that also the demand-side can have a self-correction mechanism, but with a lagged reaction *(Tsai, 2013)*.

In contrast, studies concerning supply-side adjustment propose fiscal and planning policies as taxes on second properties *(Laslett et al., 2001)*, revision of planning policies *(Agunbiade et al., 2014, Morrow, 2001, Oxley, 2011)* planning and supply through public housing programmes *(Kauko, 2012, Nordvik, 2006, Whitehead, 2003)*. The results of public housing programmes revealed that addition to the stock of public housing increased the total housing stock and only partial crowding out occurs from public housing programmes *(Goodhart and Hofmann, 2008, Nordvik, 2006)*.

Post-restitution housing policy in Estonia reflects the change from a state controlled to a *Laissez Faire* housing sytem representing home ownership model *(Kährik et al., 2003)*.

To conclude, it can be said that though neoliberal housing policy supports home ownership, it always leaves space for households not able to fulfill their housing needs and home ownership at any cost may lead to indebtness and social exclusion.

2.2 Housing and Macroeconomic Development

The main aim of this section is to identify criteria which most affect the sustainability of the housing market and a country's economic development.

Macroeconomic policy is generally viewed as being committed to three goals: price stability, employment creation, and growth. As housing represents an important share of the economy, concerns about relationships between housing markets and the wider, or macro, economy are justified. The areas of interest are interrelations between house prices and general inflation in the economy, mortgage rates and interest rates generally, housing expenditure and national expenditure, prices and unemployment, residential investments, housing and the construction industry, etc. *(Oxley, 2011)*.

Wide interest in finding connections between housing and macroeconomics started in the 1980s as forecasting institutions failed to predict the 1980s consumption boom. Most research was carried out in the UK and the USA and most of the results confirmed that a relationship between the housing sector and

macroeconomics exists. In the UK, interest in the relationship between housing and macroeconomics began in the second half of the eighties with the observation of a correlation between changes in house prices and a boom in consumers' expenditure. According to Meen, consumption grew in excess of 5% in each year between 1986 and 1988 – well above the economy's productive capacity – whereas real house price growth averaged 13% per annum over the period. In policy terms, these movements were highly inflationary *(Meen, 2003)*. The consumption boom led to an over-relaxation of monetary policy and lending. He also found that equity withdrawal – the propensity to borrow on mortgage more than is required to finance the purchase of a home – rose dramatically, reaching almost 7% of household income in 1988. Similar findings were apparent in the Netherlands and Scandinavian countries *(Boelhouwer, 2000)*. Mortgage funding and debt grew faster than GDP in most countries *(Scanlon et al., 2011)*.

Some authors are concerned about the co-movements of residential investment, construction volumes and GDP, while others focus on price-to-income and loan-to-value ratios.

The findings confirmed that the percentage standard deviation of residential investment is twice that of nonresidential investment. Consumption, residential investment and GDP are all positively correlated and residential investment leads GDP *(Davis and Heathcote, 2005)*.

Ruddock and Lopes compared GDP per capita and percentage of gross value added in construction and found that the level of construction activity rises as the level of GDP rises, but finally falls mainly in industrially developed countries *(Ruddock and Lopes, 2006)*. In Hong Kong, results confirmed the relationship between construction output and house prices. Causalities were found in both the short-run and the long run as well *(Zheng et al., 2012)*.

Dreger and Kholodilin studied data from 12 industrialized countries (as country specific analysis would be problematic, given a small number of bubbles) and made conclusions that money supply triggers a signal for a bubble when it rises more than 20% above its trend development *(Dreger and Kholodilin, 2011)*. Though they found that other important variables appeared to be price-to-rent and price-to-income ratio, findings in the US revealed that error correction models cannot be used for house price with rents as a fundamental factor.

In Finland, the loan-to-GDP ratio is used as a measure of bank lending. Other important indicators are mortgage rates, incomes, loan stock, real interest rates, price-to-income and price-to–rent ratios. The stationary, long-run relation between real housing prices, real aggregate income, loan-to-GDP ratio and the real after-tax lending rate was confirmed, so that the variables cannot drift appart in the long run *(Oikarinen, 2007)*. Still, in industrialized countries credit growth exerts more influence than credit-to- GDP ratio *(Dreger and Kholodilin, 2011)*.

Welsch points out that growth, employment and price stability are usually viewed as involving trade-offs. No matter how strong macroeconomic trade-offs

actually are, it is evident that evaluation of a multi-dimensional system of goals and the success of the respective policies requires an appropriate weighting of the constituent goals *(Welsch, 2011)*. Price stability is one of the important goals. Iacoviello and Neri studied the US housing market at the beginning of the twenty-first century to determine if fast growth in housing prices and a decline thereafter are not just a passive reflection of macroeconomic activity, but might be one of the driving forces of the business cycle. They reached the conclusions that housing demand and housing supply shocks explain roughly one-quarter each of cyclical volatility of housing investment and monetary factors explain between 15 – 20% of cyclical volatility *(Iacoviello and Neri, 2010)*. Ghent and Owyang found that housing appears to be an important driver of cyclical fluctuations in the US at the national level *(Ghent and Owyang, 2010)*.

Chirila and Chirila found that volatility of business cycles is two times higher in developing countries than in developed countries *(Chirila and Chirila, 2011)*. In countries in transition, the real estate market cycle is more unbalanced than the economic cycle *(Geipele and Kauskale, 2013)*.

Kazemi, *et al* studied house price fluctuations in Tehran and reached the conclusion that house prices rise during an economic downturn because investors have a tendency to invest in the house market as in capital merchandise *(Kazemi et al., 2011)*. Risk-taking and business cycles were investigated in Germany by Popescu and Smets and they reported results that the historical decomposition of the contribution of the various shocks to the current recession shows that both risk aversion and uncertainty shocks have played a role. However, the financial shocks have had a more significant negative contribution to economic activity *(Popescu and Smets, 2010)*.

If former house price booms did not occur along with consumption booms, then the liberal financing accelerated a change from patient borrowers to impatient ones, as noted by Iacoviello and Neri *(Iacoviello and Neri, 2010)*. Findings in Greece by Brissimis and Vlassopoulos revealed that, in the long run, a line of causality running from housing loans to housing prices is not confirmed. Short-run analysis however provides clear indications of a contemporaneous bi-directional dependence among housing loans and housing prices *(Brissimis and Vlassopoulos, 2009)*.

Findings of Mikhed and Zemčik also confirm that increased availability of credit will raise demand for property, they also argue that credit growth, which can be triggered by rising property prices, is one of the most consistent and robust leading indicators of a future financial crisis *(Mikhed and Zemčik, 2009)*.

Research in Estonia revealed that the presence of a boom and the probability of a crisis on the Estonian housing market were forecasted by the following indicators: rapid growth in loan volumes, liberalised terms for loans, taking high risk loans, the growth of the loan portfolio, low interest rates, fast economic growth, overvalued properties, positive expectations for the future and large foreign capital inflow *(Ahmet, 2010, Fainstein and Novikov, 2010, Kolbre et al., 2009)*.

The Estonian research group found that significant indicators to price change were money supply and interest rate *(Kolbre et al., 2009)*, while according to the findings of Iacoviello and Neri, in the US, monetary factors explain less than 20 percent, but have played a bigger role in the housing cycle at the turn of the century *(Iacoviello and Minetti, 2008, Iacoviello and Neri, 2010)*.

It could be summarised that in many economies, credit markets and housing markets play more important economic roles at the macro level than will be found in most textbooks. The credit markets both help to drive house prices and influence consumption and residential construction, which serve as channels transmitting house-price fluctuations to economic activity.

One of the important issues is also the decline of asset value during the recession. Existing borrowers face increased risk of negative equity. The *ex post* user cost can take on negative values as rates of capital appreciation in house-price booms have sometimes exceeded interest and other costs of owning a home.

As in other industries, assessment of fair value should be introduced into the housing market. David Prochàzka points out that fair value is a hypothetical value reflecting fair conditions and positions of all market participants. In many cases, an estimate of such conditions has to be made in order to derive fair value *(Kauko, 2010, Prochàzka, 2011, Scanlon et al., 2011, Strouhal et al., 2011)*.

Over the last 30 years house prices have over- and under-performed the growth of GDP in most of the European countries. Could we call this overshooting a "bubble"? Jowsey characterizes a housing "bubble" as a rapid speculative rise in house values until they reach unsustainable levels relative to incomes or rents or some other economic fundamentals. There may then be a decrease in house prices that results in many owners ending up in a position of negative equity, their mortgage debt being higher than the value of the property *(Jowsey, 2011)*.

Lawson defines asset-price bubbles as situations where borrowing and investing are fuelled by expectations of rising prices resulting in a crash *(Lawson, 2009)*. Dreger and Kholodilin refer to this situation as herd behavior *(Dreger and Kholodilin, 2011)*.

Referring to the research of many others, Coconcelli and Medda define the term „speculative bubble" as a situation in which excessive public expectations of future increase in prices causes prices to be temporarily raised above their fundamental value *(Cocconcelli and Medda, 2013, Laslett et al., 2001)*. Coconcelli and Medda also identify a speculative real estate bubble in Estonia between 2000 and 2009. Main reasons of the bubble were an increased volume of foreign capital resulting in substantial credit expansion and risk- taking. Kolbre *et al.* are relatively modest and call the situation in Estonian housing market a "boom" caused by an increase of the money supply and a decrease of mortgage interest rates *(Kolbre et al., 2009)*. Lopreite and Scarpino identified speculative bubbles in Spain and Ireland *(Lopreite and Scarpino, 2010)* – both of these countries are of specific interest because of their high owner-occupancy

rate. Some authors argue that a bubble reperesents a long period deviation from the fundamentals. The question remains, what should we call a long period in this case? In Estonia, the house prices started to rise in three years after the recession, inclinations may just represent transition difficulties as time series for the analysis are still too short.

As GDP, inflation, money supply, construction volumes, residential investments, house prices, mortgage rates and debt to GDP ratio and incomes are all important indicators, the influence of unemployment on the housing market and *vice versa* is not clearly identified. In the UK, the effects of housing on labour markets are straightforward. Studies showed that prices have a permanent effect on the level of unemployment *(Meen, 2003)*. In the USA, housing prices appeared not to be good leading indicators for employment at either national or region level *(Ghent and Owyang, 2010)*. In the the study by Lopreite and Scarpino the relationship between the housing market and employment was found to be modest *(Lopreite and Scarpino, 2010)*.

From the point of view of sustainability, unemployment strongly affects the ability to repay mortgage debt and even to pay for housing services.

The cyclical nature of the economy and the housing market, accompanied by house price volatility and rising indebtness, raises the question of housing affordability.

2.3 Housing Affordability and Sustainability

Most of the research referred to in the previous subsection refers to the problems of owner-occupied housing and affordability. The home ownership rate in the UK for the period 2011–2016 was forecast in 1998 to be 71,7% *(Meen, 1998)*. The actual rate in 2012 was 66,7% *(EUROSTAT, 2014)*, which is very close to the forecast.

The sustainable development of the economy is one of the most important objectives for many countries. It is commonly agreed that sustainability contains besides economic targets equally social and environmental targets. “Housing system consists of sustainable development projects, sustainable construction of residential buildings, sustainable living environments and sustainable livelihoods. These subsystems are interrelated with each other and have the broader objective of achieving economic, environmental and social sustainability. Sustainable housing aims to ensure that everyone, including everyone today and in future generations, has a decent place to live” *(Li and Shen, 2002)*.

Challenges to increase sustainability and affordability include among other issues separation of needs and wants, intergenerational equality and global inequality *(Arman et al., 2009)*.

Key question of housing market sustainability is affordability and housing cannot be sustainable unless it is affordable. Affordable housing is defined in the Housing Europe Review *(CECODHAS, 2011)* as: “generally housing that is

available for purchase or rent at a market value affordable for the majority of the population", but the term is also used to describe housing provided at sub-market prices to households on low income.

Housing affordability is dependent on the economic development of a country (region) and reflects the ongoing cost of housing related to the household income. The ongoing cost of housing is either rents or monthly mortgage payments *(Leishman and Rowley, 2012)*. As the population of a country, city or county consists of different households in different locations with different social status and having different incomes, the questions to answer are: affordable to whom, on what standard of affordability and for how long? *(Stone, 2006)*.

Lack of affordability is not the only form of housing deprivation, in addition there could be a variety of other forms – housing fails to meet physical standards of decency, apartments are overcrowded, unsafe or are in an inaccessible location. Haurin's research focused on the influence of income variability to home ownership and he made two important conclusions: first, that variability of income reduces probability of ownership and second, if wealth constrained households do qualify for loans, they purchase a smaller amount of housing compared to the desired area *(Haurin, 1991)*. Stone supports the residual income approach to housing affordability *(Stone, 2006)*.

Kallakmaa-Kapsta constructed a housing affordability index for the Estonian housing market (mortgage payment restriction as 30% of a households' net income) and made conclusions that, since 2009, an average household can afford to buy an average two-room flat in Tallinn *(Kallakmaa-Kapsta, 2013)*. Our previous research revealed that the average ratio of house price to income in Estonia was 4,1 in 2008; 2,8 in 2009; 2,9 in 2010 and 3,0 in 2011. In 2011 the figure for the lowest income quartile was 8.1; for the second 4,8 and for the third 3,5 *(Nuuter and Lill, 2013)*. Suhaida *et al.* classify median home price to median household ratio as follows: Severely Unaffordable ≥ 5,1; Seriously Unaffordable 4.1–5.0, Moderately Unaffordable 3,1–4,0; Affordable ≤ 3,0 *(Suhaida et al., 2011)*. It corresponds with housing policies in many developed countries, where affordability is the relationship between the housing cost and incomes, with no more than a certain specified percentage of income (ranging between 25 to 35%) *(Mulliner and Maliene, 2011)*.

A preferred measure of affordability is the ratio of lower quartile owner-occupied house price to lower quartile household earnings *(Leishman and Rowley, 2012, Meen, 2012)*. As incomes are extremely diversified and the situation is worsening, only 60% of the population of Estonia can afford to buy a home even if, for some of them, a home is moderately affordable *(Nuuter and Lill, 2013, 2014)*.

Broadly, affordability means the ability to acquire a housing unit and sustainability refers to the capacity to pay over the longer period (mortgage length). This raises another issue which makes life cycle analysis highly misleading. Housing cost in Estonian statistics represents maintenance cost (including services) and the extreme minority of rents (most of which are rents

with rent ceilings in the social housing sector) as owner-occupied housing counts for 96% *(Nuuter and Lill, 2013)*. Actual housing cost, especially for those who acquire a home for the first time and with mortgage obligations, is much higher.

Mortgage payments are not included in housing cost statistics in Belgium, France, Greece, Italy, Luxembourg and Portugal *(Garrido-Yserte et al., 2012)*. This might not be misleading if the share of home ownership is small, but there are worries in Spain where the weight of housing expenditure in Consumer price Index (CPI) is only 10%, but the actual housing cost is considerably higher *(Garrido-Yserte et al., 2012)*. At the same time, Spain and Ireland have owner-occupancy rates of about 85% *(CECODHAS, 2011)*. In the Nordic countries, mortgage payments are included in the housing cost *(Lujanen, 2004a, b, d)*.

In addition, the cost of maintenance is growing, as the housing stock contains buildings of different quality and age. One of the key aspects of maintenance cost is the quality level of the existing stock. In order to analyse the construction industry's economic sustainability after the worldwide economic crisis, among other important issues, Ruddock stresses the importance of retrofitting of the existing stock and addresses different situations for "starters" in housing markets *(Ruddock and Ruddock, 2010)*. Retrofitting in turn adds pressure to the housing cost because sustainability parameters, including but not limited to intergenerational equality, economic feasibility, social acceptability, energy efficiency and minimisation of waste must also be considered. So the challenges of sustainability are somehow in conflict with affordable housing, as sustainability parameters are costly *(Arman et al., 2009)*.

Leischman and Rowley confirm Whitehead's qualification of policy categories to reduce the affordability problem: "reducing the average price of housing, policies to promote higher household incomes or to lower house prices (or rents) specifically for households unable to access housing and policies to reduce housing costs" *(Leishman and Rowley, 2012, Whitehead, 2007)*. For the UK, adequate investment and competition among different providers - public, non-profit and private, would improve housing affordability *(Whitehead, 2003)*.

Meen defined sustainable home ownership as "the rate of owner-occupation that is consistent with the economy's underlying growth path". This implies that housing is affected by the state of the macroeconomy and *vice versa*: it can potentially affect the macroeconomy *(Cocconcelli and Medda, 2013, Ghent and Owyang, 2010, Gyourko, 2008, Meen, 1998)*. That is why consideration of macroeconomic variables should be an essential tool for the assessment of housing policy and its sustainability.

Recent research broadens the view of sustainability from economic variables to social and environmental-ecological aspects, namely, quality and value stability of houses, location, energy consumption, traffic and employment, to list a few. According to *(Kaklauskas et al., 2011)*, the decision-making must include social, cultural, ethical, psychological, educational, environmental, provisional, technological, technical, organizational and managerial aspects.

Strouhal suggests that qualified board oversight and robust risk management is not limited to financial institutions *(Strouhal et al., 2011)*. In a more controlled financial environment it might be possible to directly restrict the loan to value ceiling to 80-85% typical to continental Europe *(Laslett et al., 2001)*. Based on Estonian research, a loan-to-value ratio of 2/3 was suggested *(Kallakmaa-Kapsta, 2013)*. But we are convinced that this reduces the ability for more households to acquire homes and still the most crucial factor for lenders is insolvency caused either by illness, death or unemployment of one family member or even divorce.

Sustainability of the current tenure structure was also questioned in earlier Estonian research *(Kährik et al., 2003, Paadam, 2009a, b)*.

Housing affordability and sustainability issues are generally analysed from the country or regional perspective. No research was found on integrated multiple criteria assessment of housing sustainability which compares the housing markets of different countries. As an individual or economic agent in the housing market is analysed from the point of view of economic welfare, economic development and sustainability of a country should be the cornerstones of excessive home ownership.

House price trends, connections between macroeconomic development and housing, supply and demand and other issues are examined and forecast using various housing market models.

2.4 Housing Market Models

In this section we discuss different approaches to housing market modelling.

Common topics of housing market research are utility or equilibrium problems, supply and demand models and identification of housing bubbles and their connection with the economy. Quantitative models could be classified as econometric causality models, time series analysis and large- and small-scale frameworks *(Brooks and Tsolacos, 2010)*.

The key researchers in this area have used various methods depending on their research focus.

At present, there are two elementary methodological approaches to the modern macro econometric modelling of economies - Dynamic Stochastic General Equilibrium models (DSGE) and Cointegrated Vector Autoregression models (CVAR).

Representative of recent equilibrium models is estimated dynamic stochastic general equilibrium model of the US economy using Bayesian Estimated DSGE Model to assess influence of housing demand, housing technology and monetary factors on the volatility of housing sector investment and housing prices *(Iacoviello and Neri, 2010)*. Wickens argues that DSGE macroeconomic models are too stylized, it is necessary to take great care in interpreting their predictions, especially for policy purposes *(Wickens, 2010)*.

Rosenthal in turn focuses on theoretical equilibrium conditions using Engle-Granger two step model, Nordvik uses regression models *(Nordvik, 2006, Rosenthal, 1999)*.

Aggregate consumption functions were constructed by Barba and Pivetti *(Barba and Pivetti, 2009)* and an implicit rental rate for homeowners was suggested by Muth *(Muth, 1989)*.

Many researchers have used VAR techniques to identify the house price dynamics, long–run structural models of economy, economic trends, etc.

VAR using Granger causality test was used by Goodhart and Hofmann in 2008, Musso et al (2011) applied SVAR model to identify connections between real house prices, residential investment and mortgage debt, Popescu and Smets (2010) used VAR to compare risk and uncertainty shocks and Hui et al (2012) used VAR to provide a measure of the fundamental house price series *(Goodhart and Hofmann, 2008, Hui et al., 2012, Musso et al., 2011, Popescu and Smets, 2010)*.

A large-scale Bayesian VAR model was applied by R.Gupta in 2012 to identify connections between monetary policy and housing sector dynamics *(Gupta et al., 2012)*.

Impacts of fiscal policy to current account in 155 countries were identified using the panel vector autoregression (PVAR) method *(Endegnanew et al., 2013)*.

Regression model, and augmented Engle-Granger test was also used by Hepsen and Vatanserver *(Hepsen and Vatansever, 2012)*.

Miles applies generalized autoregressive conditional heteroskedasticy GARCH technique *(Miles, 2009)*.

Business cycle volatility in the Central and East European countries was calculated using autocorrelation function *(Chirila and Chirila, 2011)*, probability of the occurrence of house price bubble was tested using logit model *(Dreger and Kholodilin, 2011)*.

A panel data approach was justified by Mikhed and Zemčik to test for bubbles and even Monte Carlo simulation was applied to establish a new house price stress test *(Follain and Giertz, 2011, Mikhed and Zemčik, 2009, Tsai, 2013)*.

The world-wide recession brought along criticism of the incomprehensibility of large scale macroeconomic models, doubtful data used and the implicit view that markets and economies are stable. Besides, some models ignore the fact that supply of housing has two components: the supply from the existing stock and the supply from new building *(Oxley, 2011, Ruddock and Lopes, 2006, Ruddock and Ruddock, 2010)*. In addition, many models ignore the fact that the rental market and the house market should be treated differently.

The need for a multidimensional approach to assessment of housing markets led to multiple criteria assessment models to assist policy makers.

In 2002, Li and Shen developed a decision-support model for sustainable housing indicators using fuzzy-set theory – SHIFT *(Li and Shen, 2002)*.

Regional planning indicators, information management and evaluation of policies to enchance sustainability are recently popular areas of research. M.Aguinbiade with his colleagues studied functions of government in the delivery of land for housing production *(Agunbiade et al., 2014)*.

A conceptual framework of local indicators was elaborated by Tanguay et al. in 2010, sets of ecological indicators were proposed by Rosales (2011) and indicators for affordable housing construction technologies were elaborated by Wallbaum in 2012 *(Rosales, 2011, Tanguay et al., 2010, Wallbaum et al., 2012)*.

Fitzgerald et al. (2012) sought to address sustainability of different regions via multiple indicators using environmental, socio-economical, quality of life and transportation indexes and constructed a Sustainability Evaluation Metric for Policy Recommendations (SEMPRE) *(Fitzgerald et al., 2012)*. Criteria for sustainable housing affordability in the UK were elaborated, which included economical social and environmental factors *(Mulliner and Maliene, 2011)*. The same groups of criteria were used for the evaluation of sustainability of rural areas in Greece *(Moussiopoulos et al., 2010)* and to create a standard of living model for Eurozone countries *(Křupka and Provazniková, 2014)*.

Multicriteria models to assess sustainability were created by Zavadskas et al. (2004) and applied by Kaklauskas et al. (2005) for multivariant design and multiple criteria analysis of building refurbishments *(Kaklauskas et al., 2005, Zavadskas et al., 2004)*. Mulliner *et al.* 2013 analysed sustainability of different regions of the UK and Bournaris *et al.* (2014) the sustainability of rural developments in Greece *(Bournaris et al., 2014, Mulliner et al., 2013)*.

A multidimensional assessment of perfomance in Selected EU members was conducted by *(Staničková and Skokan, 2013)*.

Having carefully considered the models described above, the author found that each was valuable in different contexts and allowed researchers to find solutions depending on their research focus. With regard to the current research, it was decided that the principles of multiple criteria assessment were most applicable as sustainability of the housing market should address economic, social and environmental aspects which are represented by numerous indicators and these are best accommodated using a multiple criteria assessment model. Such a model would need to be specifically customised for the purpose of comparison and ranking of housing markets.

3. Problems Specific to High Owner-occupation Countries

3.1 From Public Renters to Homeowners.

In the whirlwind of history, Estonia lived through two societal transformations concerning housing - nationalisation in 1940 and a restitution and privatisation process of property starting in 1991.

Restitution restored the rights of formerly expropriated property owners and created a private rental sector which accounted approximately for 3% of the total floor area of housing stock *(Paadam and Liias, 2008)*.

Public opinion considered tenants in this sector were treated unjustly as tenants in public housing had the right to privatise their housing and become homeowners. Still, privatisation somehow reproduced the social hierarchies of the socialist system as higher status usually meant higher quality housing *(Paadam, 2009a)*.

The dynamics of the change in tenure structure is presented in Table 3.1.

***Table 3.1 Dynamics of tenure structure**[*)]*

Year/structure,%	1990	1994	1999	2008	2012
Public rental	65	56	5,5		1[**)]
Private ownership	35	37	82,8	96	96
Other		7	11,7	4	3

[*)] Source: (Housing_Finance, 1998, Kährik et al., 2003, Paadam and Liias, 2008)
[**)] In 2012 the 1% public rental means social housing

From 1990 to 1994 only small changes were evident in the tenure structure. The peak of privatisation was in 1995 and in 1999 the share of private ownership was over 82%. In 2008, approximately 85% of the private housing was owner-occupied. Flats not used by the owners set up the private rental sector stock *(Paadam and Liias, 2008)*. The major driving force of privatisation was fear and uncertainty accompanied by the availability of privatisation vouchers *(Housing_Finance, 1998)*.

The paradox of the rental sector is that the shadow rental system continues in the habits of the Soviet period, as private renting functioned throughout the Soviet system beyond the legal framework most letting today is also not registered.

The Estonian housing stock is relatively old as 75% of it was built before 1981. The building stock by its year of completion is presented in Table 3.2. The figures in the table reveal that the majority of the housing stock consists of blocks of flats built during 1961-90, almost the same volumes every decade. This period is characterised by apartments of small area, as strict design restrictions were enacted, with the main problems being the small area of kitchens 4,5 - 6m^2 and corridors as well as living rooms. In 1980 these restrictions were, to some extent,

relaxed and the layout of flats in Lasnamäe, the biggest living area in Tallinn, was relatively good. A sharp shift in the average area occurred after 1996, when a feeling of liberation and a new generation of well off businessmen came to the scene. It resulted in extensive consumption much above needs and a sense of reality occurred only after shifts in energy prices.

Table 3.2 Estonian housing stock by the year of completion in 2012 [*)]

Year	Before 1919	1919-45	1946-60	1961-90	1991-95	Since 1996	Total
Housing units	61 880	93 650	67 720	399 810	18 510	16 250	657 820
% of total	9,4	14,2	10,3	60,8	2,8	2,5	
Average area, m^2	67,1	60,5	60,5	56,6	61,6	97,5	

*) *Source: (Statistics_Estonia, 2014)*

Due to the composition of the housing stock by the year of completion and lack of adequate maintenance and repair during the Soviet period, the housing stock is in constant need of refurbishment. The quality of the housing stock and the main complaints of residents are presented in Table 3.3.

Table 3.3 Quality of the Estonian housing stock in 2012, households % of total [*)]

	Average	Urban resident	Rural residents
Good or very good	65,9	67,8	61,3
Satisfactory	28,1	27,4	29,9
Poor	5,9	4,8	8,8
Main complaints:			
• **Leaking roof**	6,1	4,9	8,7
• **Moisture in the structures (walls, basement)**	13,4	10,5	20,0
• **Noise**	27,9	32,6	17,2

*) *Source: (Statistics_Estonia, 2014)*

As these figures represent processed assessments by residents during the census of the population, they must be treated with some caution, as residents have no competence to assess the real quality of structures and technical installations. Still, 34% of households live in satisfactory or poor quality housing units. There is a difference between the situations of urban and rural residents. Rural residents live in lower quality housing units and the complaints of 28,7% of households concerning leaking roofs and moisture problems do not support the idea of sustainable housing. Complaints about noise in urban housing are a sign of poor insulation.

Another problem concerning quality of housing is the lack of technical installations. Most vulnerable households, retired, single people and families with children are unable to provide for these services at their own expense. A

lack of running water and central heating is a major problem for those families. The quality of technical installations is presented in Table 3.4.

Table 3.4 Technical installations, 2012, household's % of total

Services/Household	Central heating	Hot water	Running water	Absence of sewer system
Estonia, total	65,8	81,3	94,5	5,0
Single, over 65 years	59,3 *)	72,7	90,2	7,0
Family with three or more children	Not available	87,6	99,0	1,6

*) *Retired family*

Quality of housing refers to a constant need for management and maintenance. Part of the national policy was the privatisation of the municipal maintenance companies accomplished by the year 1997 *(Paadam and Liias, 2008)*. In 1995, EKHHL – the Association of Estonian Facilities Administrators and Maintainers was founded. In 2000, EKHHL accepted the principles of professional training and qualifications. Competence levels in the service rose noticeably but, unfortunately, homeowners were not so eager to respond. It became obvious that individual strategies in blocks of flats had to be institutionalised. In 1992, the flat owners association FOA was established and, by 2005, FOAs had been set up in 3/4 of privatised apartment blocks *(Paadam, 2009a)*. Due to the mistrust shaped during the Soviet period and the lack of finance, reaching consensus among members of FOAs is a complicated task. Heterogeneity of the owners and attitudes of elderly people leave some blocks of flats without proper maintenance.

3.2 Construction and Housing Market

During the boom in 2003 – 2007, the construction market grew on account of new buildings. Although residential construction has been active, it has not reached the volume that would cover the normal depreciation of the housing stock. The number of residential completions accounted for only 1,0% of the total housing stock in 2007 and 0,8% in 2010. The dynamics of the Estonian housing stock is presented in Table 3.5. Along with the construction of new dwellings, purchase-sale transactions boomed in the real estate market. The peak of the boom was in 2006 and the average price of transaction reached its peak in 2007.

The housing area per resident is constantly rising but the average figure does not characterise the overcrowding of families who are not so well off.

In the period 1996 to 2006, construction prices increased 2,5 times and nominal housing prices 10 times, this means approximately 700 % in real prices *(Nuuter and Lill, 2013)*. This figure is unprecedented though house prices rose in real terms in most OECD countries over the 11 years from 1995-2006:Ireland

180%, UK 133%, Spain 105%, Australia 90%, France 99%, Sweden 104%, Netherlands 93%, USA 69%, Canada 52% *(Jowsey, 2011)*. Rosenthal points out that if the market for residential buildings is efficient, then any deviations between new building prices and construction cost should disappear more quickly than the time required for construction and Meikle argued that construction cost and land represent 75% of house price *(Meikle, 2001, Rosenthal, 1999)*.

Table 3.5 Dynamics of Estonian housing stock [**)]

Year/indicator	2006	2007	2008	2009	2010	2011	2012
Housing construction, Million euro	622,2	659,6	359,1	229,8	200,5	241,2	296,9
Incl. social care and temporary shelters	16,8	32,0	25,4	10,7	3,3	9,5	27,1
Housing units, 1000	633,1	638,2	645,2	650,5	653,6	655,9	657,8
Housing units per 1000 residents	471	475	481	485	488	489	491
Housing stock, 1000 m^2	38 360	38 760	39 320	39 780	40 090	40 320	40 530
Yearly increase, %	0,6	1,0	1,4	1,2	0,8	0,6	0,5
Yearly equivalent net income, euro	5 304	6 333	7 206	6 782	6 570	7 119	7 847
Housing area per resident, m^2	28,5	28.93	29,3	29,7	29,9	30,1	30,3

[**)] *Source: (Statistics_Estonia, 2014)*

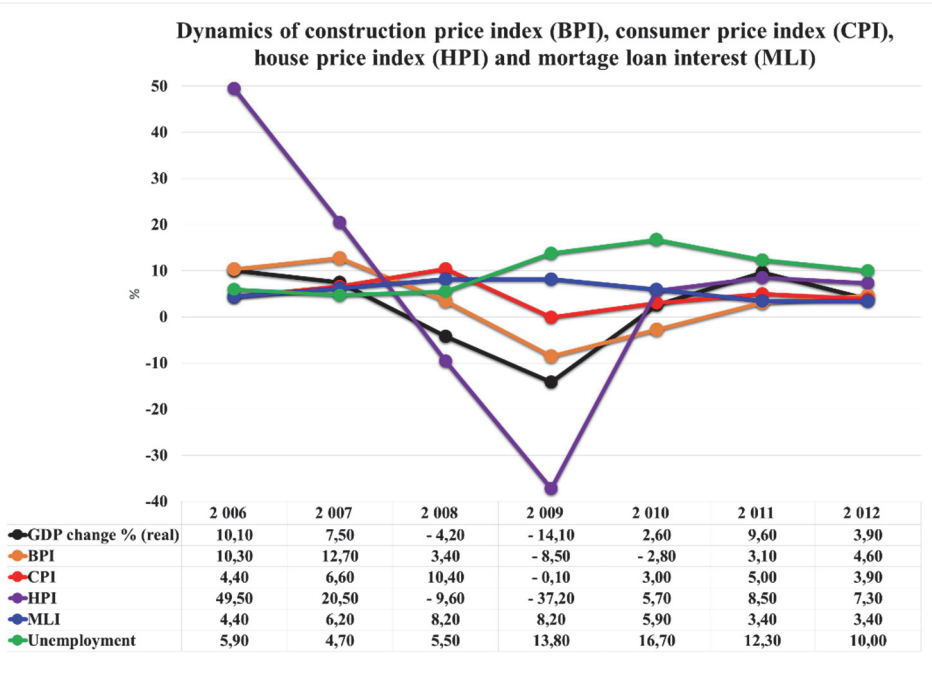
Based on this we can draw the conclusion that Estonian housing market is far from efficiency.

Mortage loan interest rates changed in Estonia from 10,3% in 2001 to 3,7% in 2004-2005, jumped up in 2008-09 to 8,2% and dropped again in 2011 to 3,4% *(Statistics_Estonia, 2014)*. Still, credit cost was higher than in the USA where mortgage loan intrerest rates were 1% at their lowest and rose from 2004 to 5,35% *(Jowsey, 2011)*.

Stabilisation of the housing market started in 2008. It is not surprising that half of the population of Tallinn, the capital of Estonia, and every 19th resident of Estonia has mortgage loans *(Mägi, 2010, Poobus, 2009)*.

Partly speculative demand lowered the quality of newly built housing stock. Residential areas were developed around Tallinn with no complete infrastructure and with poor construction and even design quality. This raises doubts over whether these housing units will survive until the end of the credit down-payment period, at least without capital repair and corresponding investment.

The peculiar dynamics of construction prices, consumer prices and housing prices is represented in Figure 3.1.



	2 006	2 007	2 008	2 009	2 010	2 011	2 012
GDP change % (real)	10,10	7,50	- 4,20	- 14,10	2,60	9,60	3,90
BPI	10,30	12,70	3,40	- 8,50	- 2,80	3,10	4,60
CPI	4,40	6,60	10,40	- 0,10	3,00	5,00	3,90
HPI	49,50	20,50	- 9,60	- 37,20	5,70	8,50	7,30
MLI	4,40	6,20	8,20	8,20	5,90	3,40	3,40
Unemployment	5,90	4,70	5,50	13,80	16,70	12,30	10,00

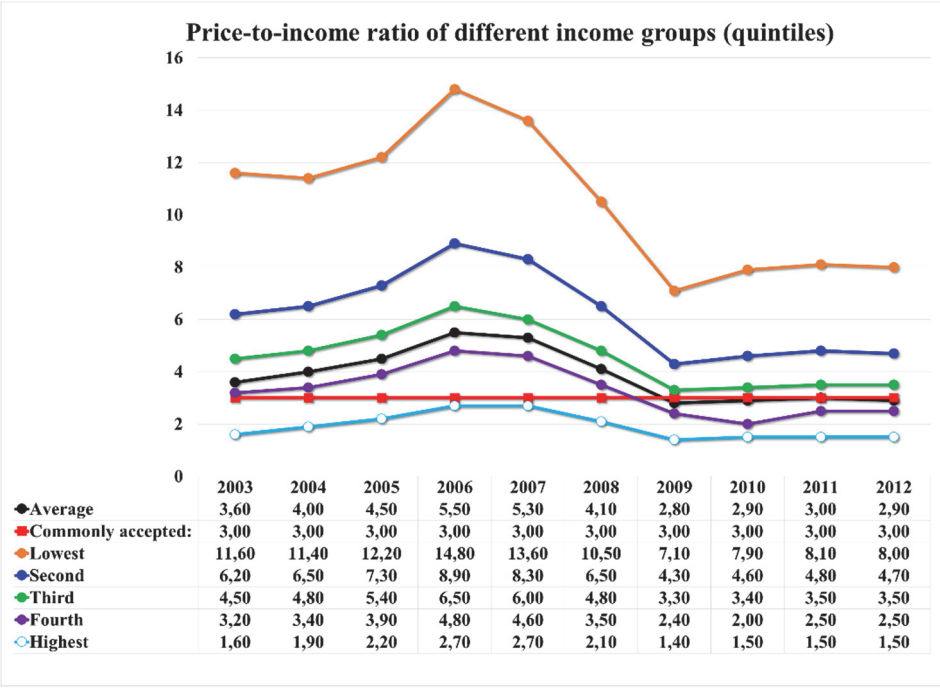
Figure 3.1 . Dynamics of construction price index (BPI), consumer price index (CPI), house price index (HPI) and mortgage loan interest (MLI), (%).

Mortgage loan interest (MLI) rose in the years of economic downturn, but dropped again in 2010 and continued to drop to a level lower than at the peak of the housing boom. Unemployment reacts to the volatility of GDP and recovers with an evident lag. The housing price index (HPI) follows a similar path, but is extremely volatile. GDP growth, consumer price index (CPI) and building price index (BPI) have smaller shifts. It is evident that HPI deviates from economic fundamentals. At the peak, it is highly inflationary and then follows a sudden drop. In 2012, the dynamics of the HPI was already ahead of GDP growth. The difference between HPI and BPI was largest at the peak and also at the bottom. Volatility of the BPI follows the path of GDP but is evidently driven by house prices. During 2013, house prices continued to rise about 10%.

3.3 Affordability for Different Income Groups

The gap between housing prices and income distribution raises the question of sustainability of home ownership. If the commonly accepted share of housing cost from a household's spending is about 30% and house price to income ratio 3,0, the average ratio does not reflect the full complexity of housing affordability.

Figure 3.2 represents the housing affordability of income quintiles.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Average	3,60	4,00	4,50	5,50	5,30	4,10	2,80	2,90	3,00	2,90
Commonly accepted:	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00
Lowest	11,60	11,40	12,20	14,80	13,60	10,50	7,10	7,90	8,10	8,00
Second	6,20	6,50	7,30	8,90	8,30	6,50	4,30	4,60	4,80	4,70
Third	4,50	4,80	5,40	6,50	6,00	4,80	3,30	3,40	3,50	3,50
Fourth	3,20	3,40	3,90	4,80	4,60	3,50	2,40	2,00	2,50	2,50
Highest	1,60	1,90	2,20	2,70	2,70	2,10	1,40	1,50	1,50	1,50

Figure 3.2 Price-to-income ratio of different income groups

Calculations are made according to the yearly available income, area per resident 30,3 m2 and household of 2,3 members. According to the calculations only fourth and fifth income quintiles can really afford to own a housing unit. In reality, the composition of households differs and large families encounter more difficulties. Usually large families occupy less area than necessary and, in rural areas, houses are without basic services. Even average affordability is extremely volatile.

The share of the housing cost in total spending reflects the same financial burden as the house price-to-income ratio. Differentials of housing cost burden are presented in Table 3.6.

Table 3.6 Housing cost as % of total spending

Cost quintile	2010	2011	2012
Estonia total	18,8	18,5	21,6
I quintile	32,0	28,0	28,7
II quintile	25,9	23,7	23,9
III quintile	20,7	18,9	20,0
IV quintile	17,3	15,9	17,1
V quintile	13,5	13,0	12,4

Housing cost does not include mortgage repayments. The first and second quintile are paying twice as much as the highest income group. Mostly due to

higher energy cost, the housing cost is rising. From 2011 to 2012 the housing cost increased by 8% *(Statistics_Estonia, 2014)*. Another issue is the poor quality of the old housing stock which needs constant repair. Low income residents (especially in smaller dwellings) avoid scheduled maintenance and hardly get on with breakdowns of systems or structures.

Severe problems with loan repayment arise with the growth of unemployment. Up to 2013, over 800 dwellings have been repossessed by the mortgage holding commercial banks in Estonia. This means that these families have lost their homes and, worst of all, still have payment obligations as house prices have decreased.

As everywhere in Europe, Estonia faces the problem of an aging population. In 2008, pensions counted for 16,3% of household members' net income. In 2012, this share was already 18,8% *(Statistics_Estonia, 2014)*. For most retired people, a change of housing location and size means both an emotional and a financial burden.

3.4 Housing Policy in Estonia

Similarly to overall economic policy, Estonian housing policy could be characterised as Laissez fair with some policy objectives. The political development follows the programs of political parties in Estonia. The first urgent need was to find a solution to the problems of tenants in restituted houses (houses which have been returned to their owners after having been expropriated during the Soviet era). Problems of tenants in restituted houses were evident in Tallinn and other larger cities where municipalities started developments to solve these problems.

Kährik et al pointed two other objectives of housing policies: to find possibilities to transfer finance to local governments for new municipal housing construction, and improve the system of social benefits *(Kährik et al., 2003)*.

In principle, these objectives remained largely political statements.

The first strategic housing development plan stressed the need for legislation to transfer ownership rights and provision of differentiated opportunities for greater individual housing choices. With no finance plan and strict division of responsibilities the plan left loose ends. Paadam stressed the need for strategies to provide higher quality social housing for the groups with the weakest capacity and redefinition of social policy goals for homeowners with severely restricted potential for sustaining their status *(Paadam, 2009b)*. This phenomenon could be called the problem of “compulsory” owners.

A social dwelling is defined as a “dwelling in municipal ownership designated to a person who needs social assistance and is supposed to include social services” *(Kährik et al., 2003)*. In reality, in most cases, social housing does not correspond to the requirements imposed by the law and rents in social and municipal housing do not differ.

The subsistence benefit is a monetary support granted to promote the ability of a household to cope with, among other things, rising housing costs. In the period 1994-96, a specific housing allowance was applied. In 1997 the two benefits were combined into a unified subsistence benefit paid by the local governments *(Kährik et al., 2003)*. *(Kährik et al., 2003)(Kährik et al., 2003)(Kährik et al., 2003)*Subsistent benefits hardly cover the basic needs of households.

According to the tax regulation, interest of the housing loans is permitted to be deducted from taxable income but liberal housing policy allowed commercial banks to determine the loan conditions.

In 1995, the Estonian Housing Fund was established and commercial banks distributed the state resources. The aim was to reduce the high interest rates but the outcomes were not successful. Some years later, the State started to guarantee the loans issued by commercial banks for some special groups such as young families, teachers, etc. In 2001, the Fund was abolished and some of its functions transferred to a self-managing guarantee fund called KredEx. This fund was more successful as many (young) families became homeowners. The most important result was support to renovation of the old housing stock as far as residents were eager to respond.

The country report of the Open Society Institute concluded that, in spite of several problems, the positive consequences of the housing reforms were a considerable reduction of public expenditure and responsibilities, an increase of private investment in housing and an increase in the quality of housing management. Negative impacts are considered to be the marginalisation of the private and public rental sector, spatial segregation, homelessness, regionally uneven housing development, a low level of new construction, housing affordability for many social groups and housing market failures *(Kährik et al., 2003)*.

These are serious social problems which reveal the lack of public support. At the same time, housing choices have expanded for wealthier households.

Leading policy still considers public investment in housing to be ineffective.

The author is convinced that public investment, to some extent, is unavoidable for social housing or the state should motivate other stakeholders. An effective rental sector is a normal part of the housing market.

3.5 Data Available

There is much concern about the data available for analysis and models *(Brooks and Tsolacos, 2010, Oikarinen, 2007, Ruddock, 2002)*. Problems and discussions about the use of appropriate variables could be overcome by harmonised rules for statistics.

The main problems concern the availability of long period time series, case occurrences and the reliability of official statistics (different rules for statistics in different countries). If long period time series are not available even in

developed countries, countries in transition encounter even more problems. Research results might be misleading or inconsistent with findings in other countries. For example, if research about the origins of the housing boom in Estonia revealed correlation with money supply and interest rate (mainly set by commercial banks) *(Kolbre et al., 2009)* then Gupta *et.al* found that, in the US, house prices show the weakest response to monetary policy shocks *(Gupta et al., 2012)*. House prices recovered rapidly and that is the case in Estonia. In the former research, the data used covered 5 years, in the second, 17 years. The same could be said of the house price dynamics. As GDP was not a significant indicator in the short run, dynamics of 15 OECD countries covering a period of 22 years, show that most important indicators are GDP growth rate and the rate of change in the real rate of interest *(Englund and Ioannides, 1997, Kolbre and Kallakmaa-Kapsta, 2006)*.

Data is not always accompanied by the specifications of what is included in the cost variables or definitions of the variables.

Excessive owner-occupation raises the following problems. Firstly, the rent level presented in national statistics represents two extremes of rental cost - municipal rental sector with controlled rent (which covers less than 1% of the housing stock) and penthouses in the old town, rented by foreigners who demand rental agreements. The rest represents the shadow economy or sub lease of so called owner-occupants. The share of renters is not presented in national statistics but is assessed according to the results of a census of the population. To analyse the housing market by comparing rents and house prices is highly misleading.

The second variable challenging the analysis is construction cost as one of the housing market fundamentals. Estonian statistics or any database does not gather data of construction costs. The last public data is from 1996. Since then, the BPI index is presented. From 1991-95 there was a drop in construction activities so the data for average cost calculated is far from perfect. Dwelling quality and services have developed, so it is rather tricky to carry on research knowing nothing about the real construction cost of houses and dwellings and which projects represent the aggregated whole. Concerns about the quality of data in construction industry were discussed by Ruddock *(Ruddock, 2002)*.

Approximate calculations by the author revealed that during 10 years 1996-2006, house prices rose 10 times and construction cost 2,5 times.

Thirdly, the housing cost represents a mixture of rents paid by residents, maintenance costs and services of renters and owners, no mortgage payments are included. As the Estonian housing stock is relatively old: 23,6% of the dwelling stock was built during the pre-war period, 71,7% before 1991 *(Statistics_Estonia, 2014)* and the number of dwelling completions account approximately 1% of the dwelling stock *(Smirnova and Sinisaar, 2009)*, there is continuous need for refurbishment. Sustainable facility management is a precondition for a sustainable housing stock, which in turn raises the housing cost *(Arman et al., 2009, Junghans, 2011)*.

In most of the countries Denmark, France, Germany, UK, Spain and the Nordic Countries *(Housing_Finance, 1998)* as well as Estonia, the households below the poverty standard qualify for subsidies. The reflection of these subsidies in statistics and their share in different countries is unclear.

Housing cost might differ according to tax policy. In Estonia, mortgage interest for first time buyers, is tax-free. Some countries introduce tax to the land, some to the property. Differences are illustrated by the share of property tax in GDP. In Estonia, the share is 0,23%, in Lithuania 0,40%, in Denmark 1,26% and in the UK 2,97% *(McCluskey and Plimmer, 2011)*. Coconcelli and Medda suggest tax reform in Estonia to avoid a possible house price bubble *(Cocconcelli and Medda, 2013)*. The author considers that, as the enactment of tax reform is time-consuming, by the time it is in force, the housing boom might be over.

The listed shortcomings and lack of data led to the conclusion that European databases give more processed data for countries than the Estonian Statistical Department, which confirms the need for an international comparison of housing markets.

4. A Multiple Criteria Model to Assess the Sustainability of the Housing Market

4.1 Introduction

Absence of sufficient data series and some important criteria in Estonia (construction cost, real housing cost etc.) and the need to include multiple criteria suggested that the best way to assess the sustainability of the housing market is by multiple criteria analysis (MCA).

To compare multiple housing market criteria from different European countries the author used European databases. It was assumed that the rules for data presented are similar for all the countries and the outcome is relatively uniform data sets for 2012.

4.2 Model Description

4.2.1 Components of the Decision Support System for Housing Sustainability Assessment

DSS-HS consists of a database, database management system, model-base, model-base management system and user interface (Figure 4.1). The system is available on the internet and can be found at the following address: *http://iti.vgtu.lt/VGTU_Lomonosov/Account/Login.aspx.*

The system integrates databases and model-bases managed by system users via the user interface. These components are closely interrelated and link smaller components of the system. The main components of the system are further discussed in detail.

4.2.2 Database and Database Management System

The DSS-HS system allows the use of different information if needed: numerical, drawings, texts, graphics and quantitative forms. Quantitative information presentation involves criteria systems and subsystems, units of measurement, values and initial significances fully defining the alternatives provided. Conceptual information means a conceptual description of the alternative solutions, the criteria and ways of determining their values and significances, etc.

In this way, the DSS-HS system enables the decision maker to get various types of conceptual and quantitative information on housing market sustainability from a database and a model-base allowing him to analyse the selected indicators and make an efficient determination. The analysis of database structures in decision support systems reveals their various uses. There are three basic types of database structures: hierarchical, network and relational *(Kaklauskas, 1999)* DSS-HS system has a relational database structure when the information is stored in the form of tables. These tables contain quantitative and conceptual information.

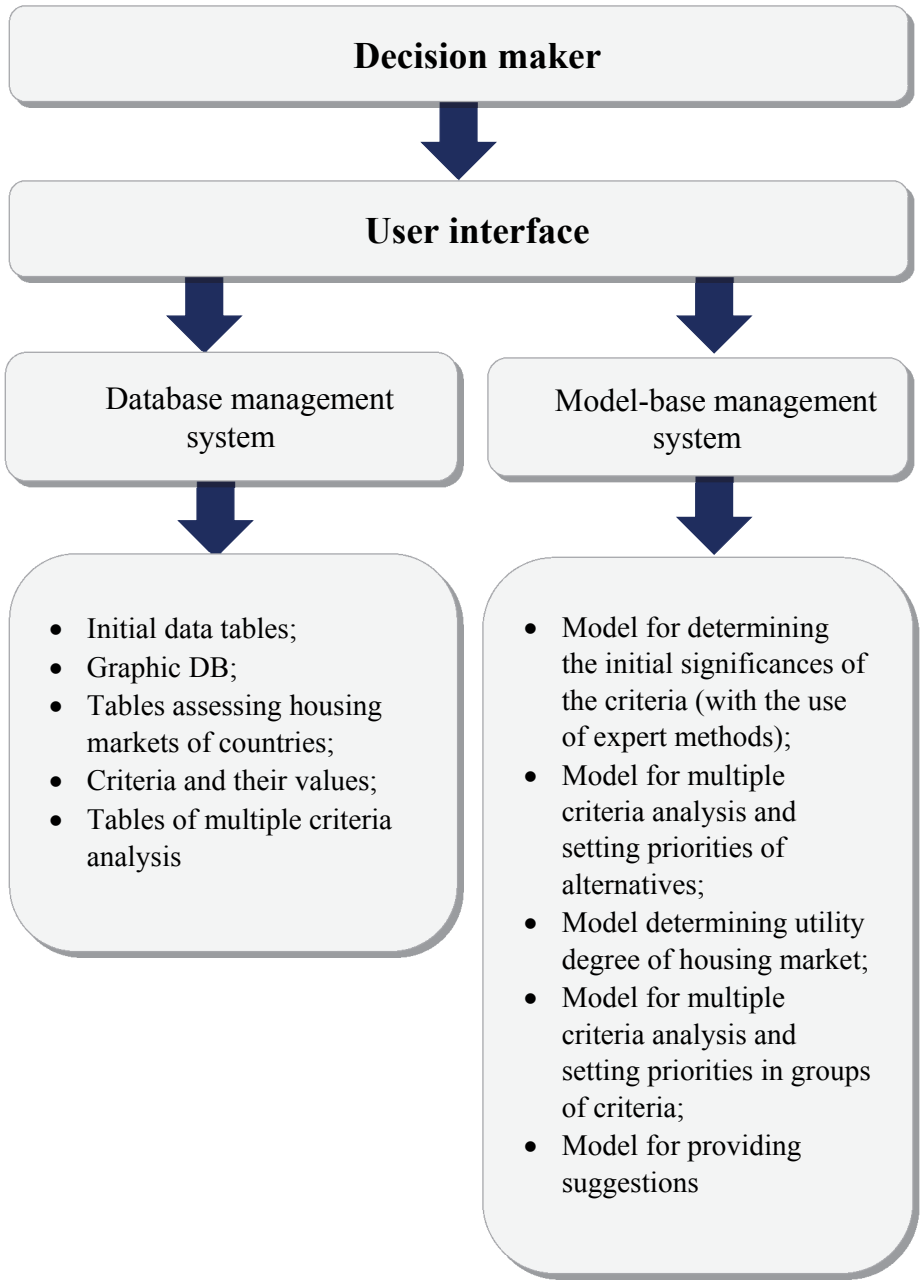


Figure 4.1 Components of Decision Support System for Housing Sustainability Assessment (DSS-HS)

Each table is given a name and is saved in the computer external memory as a separate file. Logically linked parts of the table make a relational model. The following tables make up the DSS-HS system database:

- initial data tables. These contain general facts about the housing markets of the different countries considered: general description, current housing market situation, etc.;
- graphic database, containing conceptual information on the housing markets considered, i.e. photographs, diagrams, etc.;
- tables of selected countries. These contain quantitative and conceptual information about the housing markets in each of the selected countries;
- criteria groups and their values. These contain the descriptions of criteria groups and their weights both in quantitative and conceptual terms;
- sub-criteria and their values. Sub-criteria are also described both in quantitative and conceptual forms, their dependence on the corresponding group of criteria is determined;
- the tables of housing market sustainability assessment.

The collection, processing and presentation of information for a database in a computer-acceptable form are complicated and time-consuming processes. The information collected in a database should be reliable, fully describing housing markets as well as enabling the DSS-HS system to perform an efficient multiple criteria analysis of the housing markets based on a structured system of criteria.

The process of drawing up the tables of country housing market assessment consists of the following steps:

- collection and presentation of general information about the countries (or areas) under consideration;
- establishment and conceptual description of the systems and subsystems of criteria;
- establishing criteria for choosing the units of measurement;
- determination of the initial significances of the criteria;
- determination of attribute values.

Uniform types of relational tables have been chosen to facilitate the entering of appropriate data into the database. Such a unified database also enables easy correction and introduction of new information as well as efficiently carrying out the computations.

The database tables are used as a basis for working out the decision-making matrices. These matrices, along with the use of a model-base and models, make it possible to perform multiple criteria evaluation of the sustainability of housing markets in the selected countries.

The DSS-HS database management system allows users to analyse the housing markets in selected countries by taking into account the hierarchically structured system of criteria.

4.2.3 Model-Base and Model-Base Management System

A model-base allows the DSS-HS user to determine the country with the most sustainable housing market in comparison to other selected countries. The following models of the model-base are aimed at performing this function:

- a model for determining the initial significances of the criteria (with the use of expert methods);
- a model for multiple criteria analysis and setting priorities in groups of criteria (based on the COPRAS method);
- a model for multiple criteria analysis and setting the priorities in all groups of criteria (based on the COPRAS method);
- a model for determination of housing market utility degree (based on the COPRAS method);
- a model for providing recommendations.

A model for determining the initial significances of the criteria allows the determination of weights of criteria for multiple criteria analysis of alternatives.

A model for multiple criteria analysis and setting priorities in groups of criteria performs multiple criteria analysis of housing market sustainability in each group of criteria. To assess the sustainability of excessive owner-occupied housing the indicators were divided into six groups: general economic, housing stock, housing affordability, population and social conditions, housing quality and environmental quality indicators.

A model for multiple criteria analysis and setting priorities in all groups of criteria acquires data about each country's housing market performance in each criteria group and uses this data for multiple criteria analysis of housing sustainability in each selected country and sets the priorities.

A model for determining housing market utility degree determines the utility degree of housing market sustainability in each country. The quantitative value of utility degree is provided in percentage terms.

A model for providing recommendations enables the analysis of strong and weak sides of the housing markets under investigation and provides recommendations regarding which indicators could be improved in order to make the housing market more sustainable.

4.3 Development of a System of Criteria for Housing Sustainability Evaluation

Multiple criteria analysis (MCA) allows the consideration of many aspects pertaining to housing market sustainability and we should include as many criteria as possible within the limits of the data and their compatibility.

As discussed above, economic, social and environmental criteria should be considered, but, for simplicity, we have to make a choice and choose the optimal number of indicators *(Tanguay et al., 2010)*.

There are multiple criteria to assess housing market sustainability. Much research is concentrated on urban and ecological indicators *(Rosales, 2011, Tanguay et al., 2010)* or the comparison of different urban solutions and regions *(Mulliner and Maliene, 2011, Mulliner et al., 2013, Zavadskas et al., 2004)*.

To evaluate sustainability of housing markets a comparison of different European states was carried out. This choice was aimed at determining the economic point of sustainability within the limits of available data.

The uniform data for 2012 presented in EU statistical overviews was used for this purpose *(CECODHAS, 2011, EUROSTAT, 2014, HYPOSTAT, 2013, NUMBEO, 2014)*.

To assess the sustainability of excessive owner-occupied housing, indicators were divided into six groups: general economic, housing stock, housing affordability, population and social conditions, housing quality and housing environment quality indicators. The developed system of criteria is presented in Figure 4.2.

Weights of criteria in each group of criteria were determined by experts from Tallinn University of Technology and Vilnius Gediminas Technical University. In total, 10 experts who specialise in housing and its sustainability assessment problems participated in the survey.

Respondents ranked the presented criteria according to their importance to housing sustainability. Criteria importance were rated using a 10 point scale, where a ranking of 1 represents 'not important' and a ranking of 10 represents a 'most important' criterion.

On completion of the surveys, the consistency of experts opinions was examined and the average ranking (score) of importance obtained in each group of criteria was calculated. The average results revealed that all the selected criteria were, in the experts' opinion, perceived to be important, to some extent, for the evaluation of housing sustainability.

The initial data is presented in Appendix 1.

According to the previous literature overview, the most important economic indicators are GDP per capita, inflation rate and unemployment - as in an excessive home ownership housing environment, the loss of employment is one of the main reasons for housing deprivation.

Housing stock criteria include dwelling stock characteristics, social rental stock and residential construction. Most important in this group is the home ownership rate. Our choice was encouraged by the findings of Mulliner and Maliene who combined an extensive literature review with interviews of housing stakeholders in the UK. According to priorities of sustainable housing affordability, the availability of rented accommodation ranked as the fourth most important criterion (following house prices in relations to incomes, rental cost in relation to incomes and housing quality). Availability of affordable home ownership products ranked as the eighth most important criterion *(Mulliner and Maliene, 2011)*.

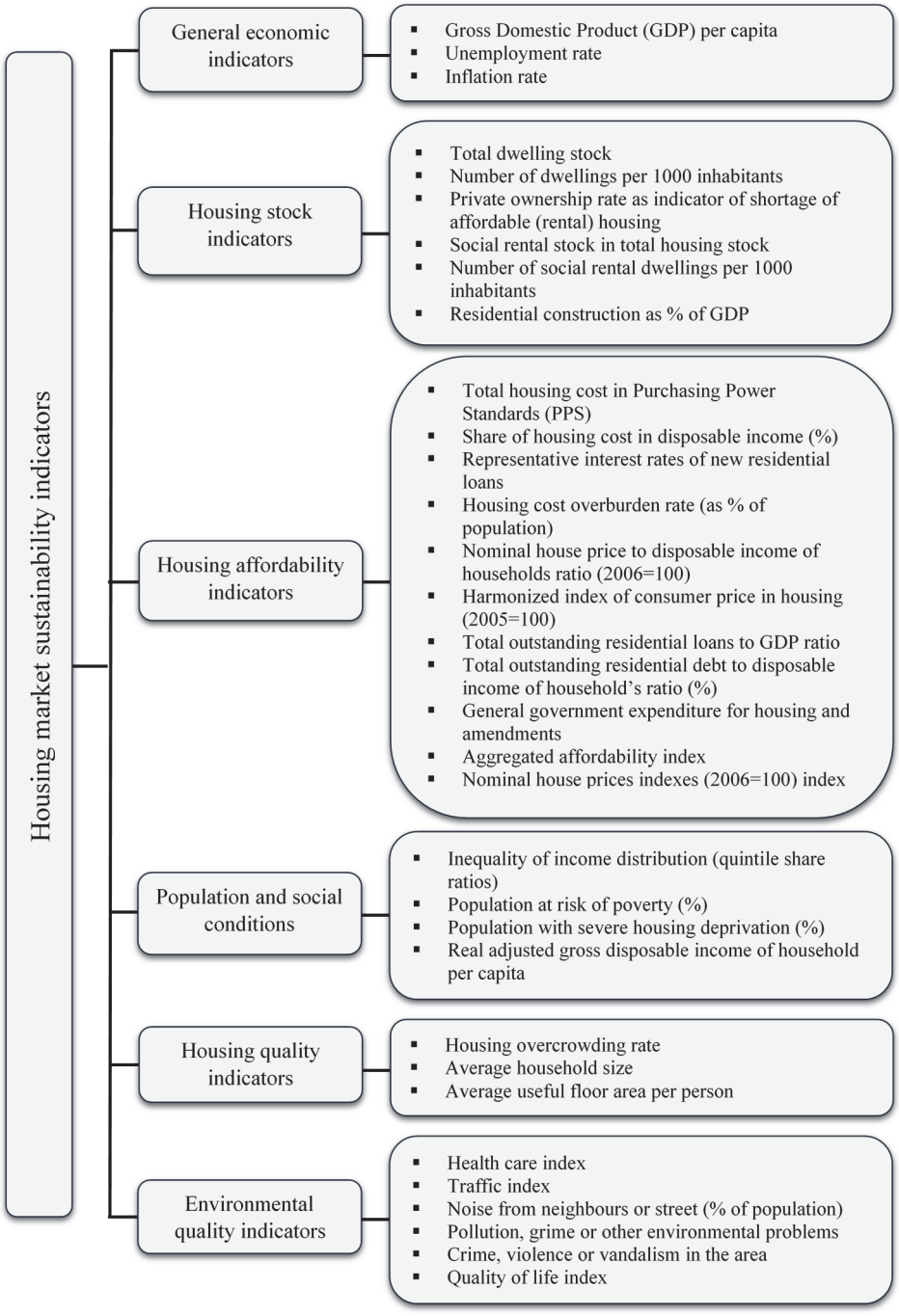


Figure 4.2 System of criteria for housing market sustainability assessment

Housing affordability indicators include cost and price criteria, residential loan ratio to GDP and interest rates along with share of government expenditures and indexes of house price and housing cost.

Population and social conditions are characterized by population at risk of poverty, housing deprivations, real income per capita and income inequality.

Housing quality indicators address the problem of differences in terms of area per resident, housing overcrowding and household composition.

Environmental criteria include most of the important criteria available, but it should be mentioned that traffic and noise criteria mostly apply to cities.

4.4 Assessment Methodology

For assessment of housing market sustainability, a method of Multiple Criteria Proportional Assessment (COPRAS) was chosen. This method is relatively simple and can provide a complete ranking of the compared countries according to the selected criteria.

There are many Multiple Criteria Decision Making (MCDM) methods that can be used for the multiple criteria assessment of alternatives, for example COPRAS, EVAMIX (Evaluation of Mixed Data), TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution), VIKOR (VIšekriterijumsko KOmpromisno Rangiranje), AHP (Analytic Hierarchy Process), etc. All these methods have been compared by *(Chatterjee et al., 2011)* as shown in Table 4.1.

***Table 4.1 Performance of some multiple criteria evaluation methods**[*)]*

Method	Calcu-lation time	Simplicity	Transpa-rency	Possibility of graphical interpretation	Information type
COPRAS	Less	Very simple	Very good	Very high	Quantitative
EVAMIX	Moderate	Moderately critical	Reasonable	Low	Mixed
TOPSIS	High	Moderately critical	Good	Low	Quantitative
VIKOR	Less	Simple	Reasonable	Low	Quantitative
AHP	Very high	Very critical	Low	Good	Mixed

[*)] Source: (Chatterjee et al., 2011)

The comparison of the presented methods leads to the conclusion that the COPRAS method (A Method of Multiple Criteria Proportional Assessment), developed by Zavadskas and Kaklauskas *(Zavadskas and Kaklauskas, 1996)*, has noticeable advantages over the other methods. Calculation time is very short, the same as VIKOR. The COPRAS method can be easily implemented to any program source code. Understanding and result checking is straightforward. Calculation results can be easily visualized and interpreted. For these reasons, for assessment of housing market sustainability in the selected countries, the COPRAS method was chosen.

An extensive review of the MCDM methods was performed by *(Zavadskas et al., 2014)*. The authors list COPRAS as one of the methods that has rapidly developed and been applied to solve real life problems. The COPRAS method proved to be efficient for application to various housing related problems. For example, *(Kildiene et al., 2011)* used this method for the comparative analysis of the European country management capabilities within the construction sector in the time of crisis, *(Kaklauskas et al., 2012)* – for quantitative and qualitative analyses of passive houses, and *(Mulliner et al., 2013)* – to assess the affordability of different housing alternatives in the UK.

Although there are many comparative studies presented in the literature, it must be stated that the actual procedures for finding a method vary greatly depending on the structure of the underlying decision problem. Tupenaite compared SAW (Simple Additive Weighting), TOPSIS and COPRAS as well as the newly developed method ARAS (Additional Ratio Assessment). SAW, COPRAS and ARAS methods provided equal results but ARAS is still in the development phase *(Tupenaite, 2010)*.

The determination of the significance and priority of alternatives (in this case, countries) is carried out in four stages according to the algorithm depicted in Figure 4.3

Stage 1. The weighted normalized decision making matrix $\hat{P}$ is designed. The purpose of this stage is to receive dimensionless weighted values of the attributes. All attributes, originally having different dimensions, can be compared when their dimensionless values are known. The following equation is used:

$$\hat{x}_{ij} = \frac{x_{ij} \cdot q_i}{\sum_{j=1}^{n} x_{ij}};\ i = \overline{1,m};\ j = \overline{1,n}; \tag{4.1}$$

where n – number of alternatives; m – number of attributes; x_{ij} – the attribute value of the j^{th} alternative; q_i – significance (weight) of i^{th} criterion.

The sum of dimensionless weighted index values $\hat{x}_{ij}$ of each criterion is always equal to the significance q_i of this criterion:

$$q_i = \sum_{j=1}^{n} \hat{x}_{ij};\ i = \overline{1,m};\ j = \overline{1,n}. \tag{4.2}$$

In other words, the value of significance q_i of the investigated criterion is proportionally distributed among all alternative versions a_j according to their values x_{ij}.

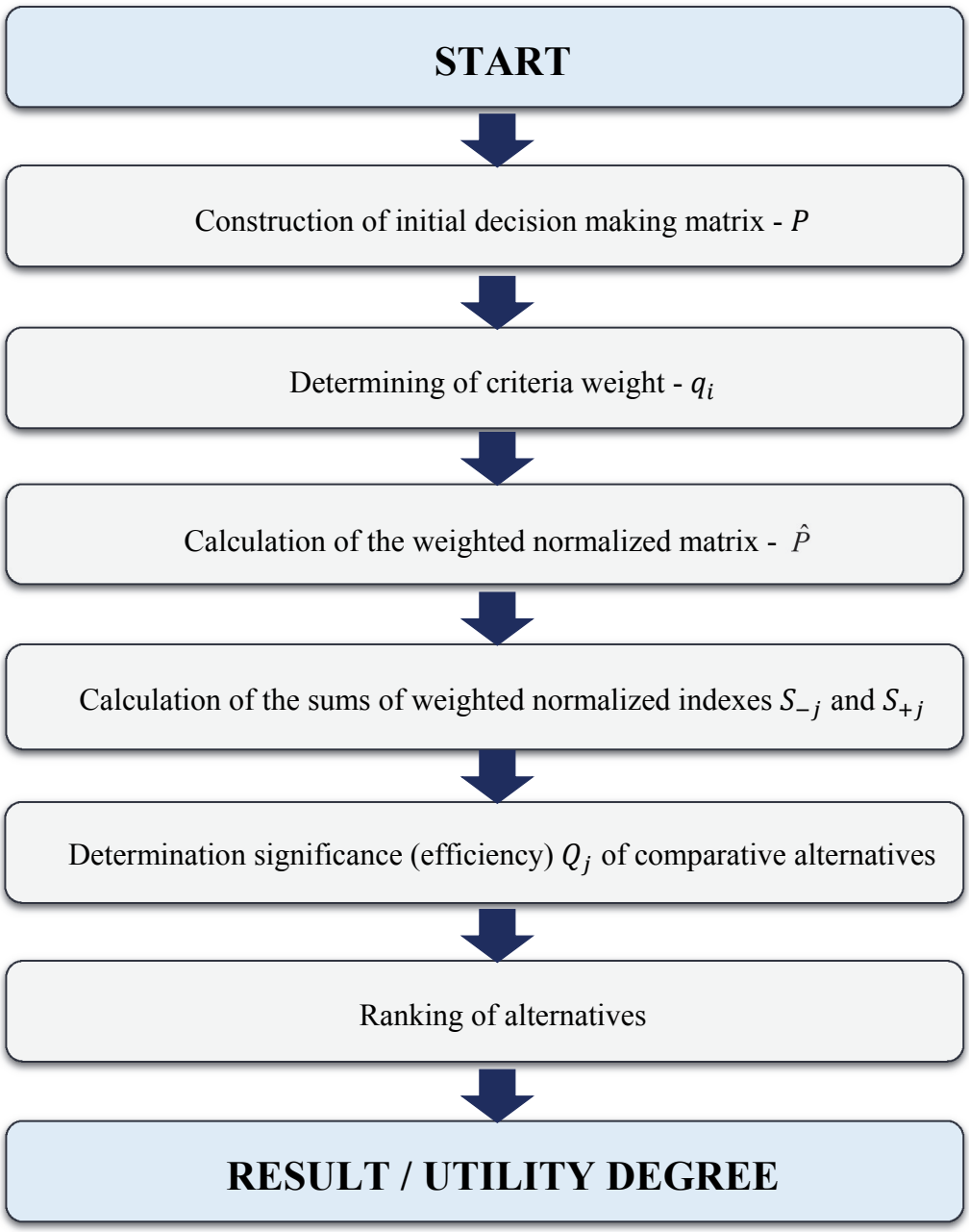


Figure 4.3 Algorithm of the COPRAS method

Stage 2. The sums of weighted normalized indexes describing the j^{th} alternative are calculated. The options are described by minimizing attributes S_{-}

$_j$ and maximizing attributes S_{+j}. The sums are calculated according to the equation:

$$S_{+j} = \sum_{i=1}^{m} \hat{x}_{+ij} \; ; \; S_{-j} = \sum_{i=1}^{m} \hat{x}_{-ij} \; ; \; i = \overline{1,m}; \; j = \overline{1,n} \, . \tag{4.3}$$

In this case, the values S_{+j} (the greater this value, the more satisfied are the interested parties) and S_{-j} (the lower this value, the better is goal attainment by the interested parties) express the degree of goal attainment by the interested parties with respect to each alternative. In any case, the sums of "pluses" S_{+j} and "minuses" S_{-j} of all alternative projects are always respectively equal to all sums of significances of maximized and minimized attributes:

$$S_{+} = \sum_{j=1}^{n} S_{+j} = \sum_{i=1}^{m} \sum_{j=1}^{n} \hat{x}_{+ij} \; ; \tag{4.4}$$

$$S_{-} = \sum_{j=1}^{n} S_{-j} = \sum_{i=1}^{m} \sum_{j=1}^{n} \hat{x}_{-ij} \; ; \quad i = \overline{1,m} \; ; \; j = \overline{1,n} \, . \tag{4.5}$$

In this way, the results of calculations may be additionally checked.

Stage 3. The significance (efficiency) of comparative alternatives is determined on the basis of describing positive (pluses) and negative (minuses) characteristics. Relative significance Q_j of each alternative a_j is found according to the equation:

$$Q_j = S_{+j} + \frac{S_{-\min} \cdot \sum_{j=1}^{n} S_{-j}}{S_{-j} \cdot \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}} \; ; \; j = \overline{1,n} \, . \tag{4.6}$$

Stage 4. Determining the priority order of alternatives. The greater the Q_j, the higher is the efficiency of an alternative.

It is possible evaluate the alternatives and to select the most efficient one. The physical meaning of the process is quite transparent. Moreover, the method allows the formulation of a reduced criterion Q_j that is directly proportional to the relative effect of the compared values x_{ij} and weight q_i on the final result.

In order to visually assess alternative efficiency the utility degree N_j can be calculated. The degree of utility is determined by comparing the alternative analysed with the most efficient alternative. In this case, all the utility degree

values related to the alternative analysed will range from 0% to 100%. The equation used for the calculation of alternative a_j utility degree is given below:

$$N_j = \frac{Q_j}{Q_{\max}} \cdot 100\% \cdot \tag{4.7}$$

In order to perform multiple criteria assessment of housing market sustainability in Estonia and other selected countries by using the COPRAS method, a computer aided Decision Support System for Housing Sustainability Assessment (DSS-HS) was developed. The system consists of a database, database management system, model-base, model-base management system and user interface.

The system allows the performance of multiple criteria assessment of housing market sustainability in each of the selected countries for six criteria groups as shown in Figure 4.2 (general economic, housing stock, housing affordability, population and social conditions, housing quality and environmental quality). The results of the assessment are interpreted as a ranking which enables recommendations to be made for the improvement of indicators in order to increase housing market sustainability in a particular country.

In order to demonstrate the practical application of DSS-HS, functions of its models and other elements, the case study covering the selected countries was performed.

5. Comparison of Housing Markets using Multiple Criteria Assessment Methods

Different EU countries have different housing policies and history, different economic development and different tenure structure.

For this case study, nine EU countries were selected: those with a high home ownership rate such as the Baltic States and Spain and, for comparison, countries with a long housing market history: UK, Denmark, Finland, Sweden and Germany. Data for the assessment was acquired from *(CECODHAS, 2011, EUROSTAT, 2014, HYPOSTAT, 2013, NUMBEO, 2014)*. Initial data is presented in Appendix 1.

At first, the assessment of housing market sustainability was performed for each group of criteria. During the analysis the normalization of the decision making matrix was performed and a weighted decision making matrix was constructed (equations (4.1) – (4.5)). Based on the matrix data, the multiple criteria assessment was performed by COPRAS methodology and the significances Q_j for each analysed alternative were calculated (equation (4.6)). The utility degree was then determined using equation (4.7).

5.1 Overall Ranking, General Economic Indicators

By all groups of criteria, the most sustainable housing market is in Denmark, closely followed by Germany and Sweden. Estonia ranked seventh, (utility degree 67,2%), Lithuania eighth (utility degree 65,0%) and Latvia ninth (utility degree 57,2%). The private home ownership rate is below 70% in all the countries ranking in the top three by overall criteria and general economic indicators (Table 5.1). The multiple criteria calculations are presented in Appendix 2.

Sweden was ranked highest by general economic indicators, followed by Germany and Denmark. In the group of general economic indicators, Estonia ranked ninth, Lithuania eighth, Latvia sixth and Spain seventh. The relatively high ranking of Latvia could be partly explained by the low inflation rate, as Latvia struggled to join the euro area. Still, for all of the three Baltic States, the criteria that most influenced the ranking, was GDP per capita (see Appendix 3) which should be improved to correspond with the high home ownership rate.

By general economic indicators, the UK ranked relatively low, in fourth place. This might be one of the explanations why home ownership rate has not reached 71% as forecast by Meen in 1998 (see subsection 2.3) The other reason might be planning constraints due to the planning permission-based system *(Whitehead, 2012)*.

For Spain and Sweden the most important economic indicator was unemployment and for the rest of countries it was the inflation rate. The author realizes that industrial countries with mature economies and housing markets cannot be strictly compared to economies in transition, but all the countries have

more or less suffered from housing bubbles and economic downturns *(Kaklauskas et al., 2011)* (Kaklauskas et al., 2011).

Table 5.1 Calculation results of countries compared

Country	Den-mark	Ger-many	Swe-den	Fin-land	UK	Spain	Esto-nia	Lit-huania	Lat-via
Indicator / ownership rate, %	64,3	53,3	69,9	73,9	66,7	78,9	96,0	91,9	81,2
Ranking, all groups Utility degree, %	1 100	2 99,1	3 97,5	4 94,1	5 87,5	6 75,3	7 67,2	8 65,0	9 57,2
Gen. economic Utility degree, %	3 76,9	2 86,2	1 100	5 66,7	4 68,3	7 47,6	9 46,0	8 47,4	6 50,1
Housing stock Utility degree, %	2 95,0	5 80.2	4 87,5	3 89,4	1 100	6 55,7	8 31,2	7 33,2	9 30,2
Housing quality Utility degree, %	1 100	2 91.0	4 68,7	3 77,6	6 63,0	5 64,0	7 51,7	8 46,5	9 38,4
Housing affordability Utility degree, %	9 60,3	1 100	8 62,1	4 74,8	7 67,22	6 67,9	2 75,2	5 71,00	3 74,9
Population and social Utility degree, %	4 93,6	3 96,7	2 97,6	1 100	5 84,8	6 80,9	7 75,8	8 70,2	9 55,8
Environmental quality Utility degree, %	2 99,1	7 72,3	1 100	5 80,9	8 68,5	3 87,5	6 78,2	4 82,2	9 59,9

General calculation results and ranking of general economic indicators are presented in Figure 5.1.

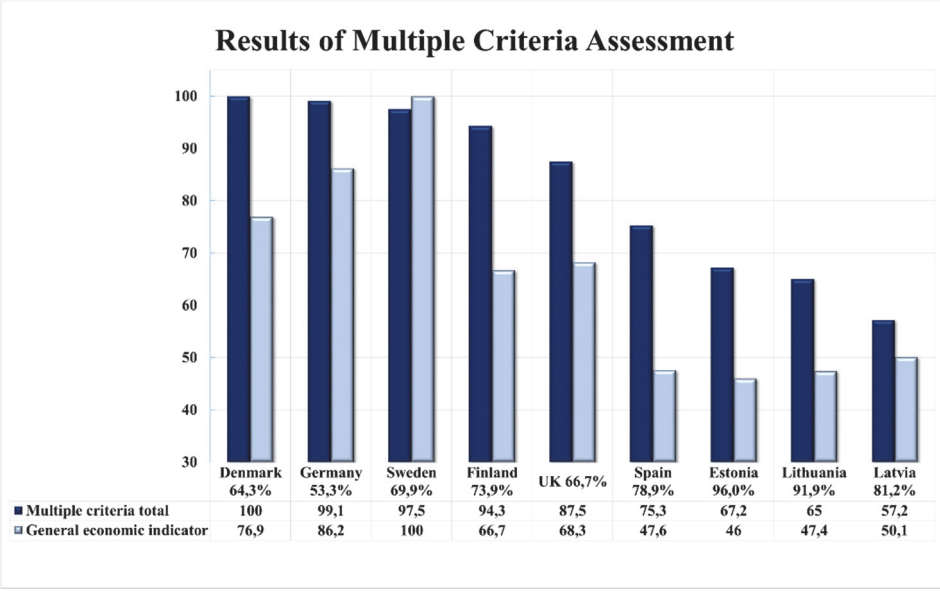


Figure 5.1 General assessment results and general economic indicators

5.2 Housing Affordability, Population and Social Indicators

Housing affordability is best in Germany, the country with the lowest home ownership rate among all the compared countries. It should be mentioned that, as Germany dominates the other countries in terms of affordability, the ranking of all the other countries varies from 75 to 60 percent.

Surprisingly, Estonia ranks second, Latvia third and Lithuania fifth in terms of affordability. This can be explained by the low ranking of housing stock and its quality, which in turn means that house prices reflect mainly sales of existing stock with only a small proportion of new houses. House prices (on average) are still relatively lower than in developed countries.

By contrast, Denmark takes last place in the housing affordability criteria but is first by the housing stock quality, as described in the following subchapter. The criteria affecting this outcome are high total housing cost, share of housing costs in disposable income and high interest rates on new residential loans and total residential debt to income.

The criteria which mostly influence housing affordability in most of the countries is insufficient government expenditure for housing and community amendments (Baltic States, Spain, Finland, Sweden, Denmark and the UK). For Germany, the most important but not significant criterion, is the housing cost overburden rate.

By population and social conditions, the leading country is Finland, followed by Sweden, Germany and Denmark, the utility degree of which varies between 93-98%. The UK and Spain take fifth and sixth place (utility degree 81-85%). Estonia ranks seventh, Lithuania eighth and Latvia ninth.

For all the countries except Germany, the most important criteria is real adjusted gross disposable income of households per capita but the need for improvement is much higher in the Baltic states.

For Germany, the most important but not substantial indicator is inequality of income distribution.

Results of housing affordability, population and social indicators are presented in Figure 5.2.

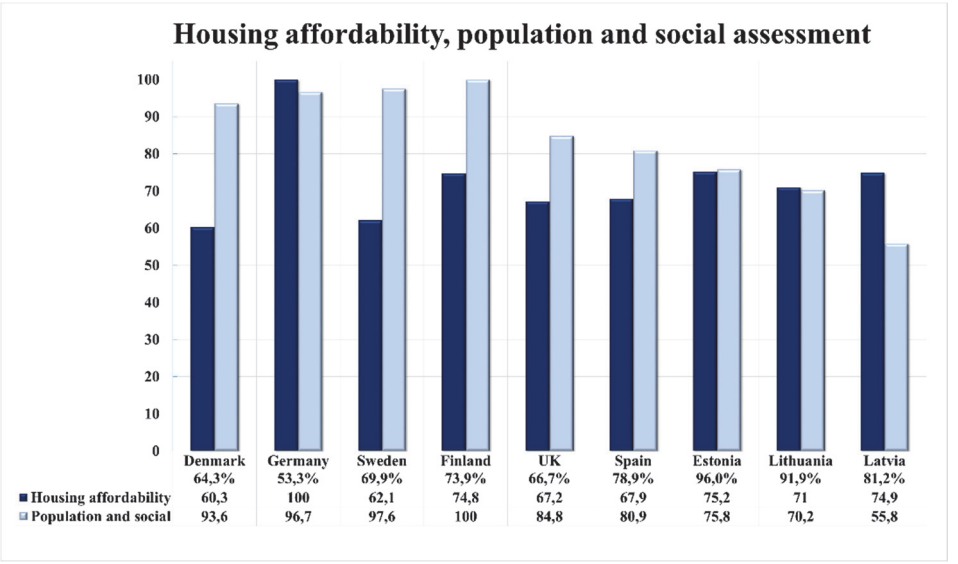


Figure 5.2 Results of housing affordability, population and social indicators

5.3 Housing stock, Housing Quality and Environmental Quality Indicators

Analysis of the results revealed that the best housing stock situation was in the UK (utility degree 100%) and the worst in Latvia (30,2%). Estonia's housing stock was ranked in eighth place (utility degree 31,7%). All the Baltic States have a remarkably low utility degree in comparison with the other countries.

The most important criterion for housing stock in Estonia was the total dwelling stock with an extremely high need for improvement. Improvement of total dwelling stock is important for Latvia and Lithuania but the most important criterion for Latvia is social rental stock as % of housing. Second and third criteria in the Baltic States were social rental stock and number of social rental dwellings per 1000 inhabitants. These results correspond with their relatively low incomes and old housing stock.

The total dwelling stock also needs improvement in Finland, Sweden and Denmark. Interesting finding occurred – if in the Baltic States insufficient dwelling stock and lack of social rental stock were "crowding out" private ownership rate, this criterion ranked second in Finland and UK and third in Spain and Sweden.

The housing quality is best in Denmark, followed by Germany and Finland.

The Baltic States are ranked last, with low utility degree (Estonia 51,7%, Lithuania 46,5%, Latvia 38,4%). The average useful floor area per person is the most important criterion in all the compared countries except Denmark, where the only important criterion is the housing overcrowding rate. It should be added that the highest space standard is in Denmark, the lowest in Finland as the

average dwelling size is small. Among the Nordic countries, Denmark leads renovation and Sweden follows more or less same pattern *(Lujanen, 2004c)*.

The housing overcrowding rate is also a significant criterion for Estonia, Lithuania, Latvia, Spain, Sweden, Germany and the UK.

Utility degrees of environmental quality indicators are relatively similar, with values ranging from 60-99%. The leading country is Sweden and the worst situation is in Latvia.

The quality of life index criterion is among the top 3 in Estonia, Lithuania, Latvia, Spain, Sweden, Denmark and UK. Crime, violence or vandalism in the area and pollution, grime or other environmental problems were in the top three for Estonia, Latvia, Spain, Sweden, Germany and the UK. The traffic criterion was important in Finland, noise from neighbours or from the streets in Denmark and Germany. The calculation results of housing stock, housing quality and environmental indicators are presented in Figure 5.3.

Figure 5.3 Results of housing stock, housing quality and environmental indicators

5.4 Suggested Home Ownership Rate for Countries Compared

The DSS-HS system enables recommendations to be made. Based on the assessment data, it is possible to determine the measures that will have the highest impact on increasing housing sustainability in a particular country. For example, the top 3 criteria that have the greatest influence in the group of "housing stock indicators" in Estonia are the total dwelling stock, social rental stock and number of social rental dwellings (Appendix 3). These indicators should be improved in order to make the Estonian housing market more sustainable in comparison to other countries (Figure 5.4)

Estonia		
Criteria describing the alternatives	Possible improvement of the analysed criteria in %	Possible increase of the market value of the alternative through increased value of the forementioned criterion, %
Total dwelling stock	5931,95	593,2
Rental stock as % of total housing stock	1800	360
Number of social rental dwellings per 1000 inhabitants	1800	360

Figure 5.4 TOP 3 criteria that have greatest influence on ranking

It is possible to determine particular improvements of indicators by using an approximation cycle.

Coming back to discussions on housing sustainability from the perspective of housing policy and the home ownership ratio, the calculations were performed in order to determine a sustainable share of home ownership in Estonia. Analysis performed in three approximation cycles revealed that, in order to increase Estonian housing market sustainability, the home ownership ratio should be reduced from 96% to 72,8% (Figure 5.*5*).

Estonia

Approximation cycle	0	1	2
The corrected value	96	75,1222	72,8025
It is determined whether the corrected value being valuated had been calculated accurately enough	21,75%	3,09%	0,35%

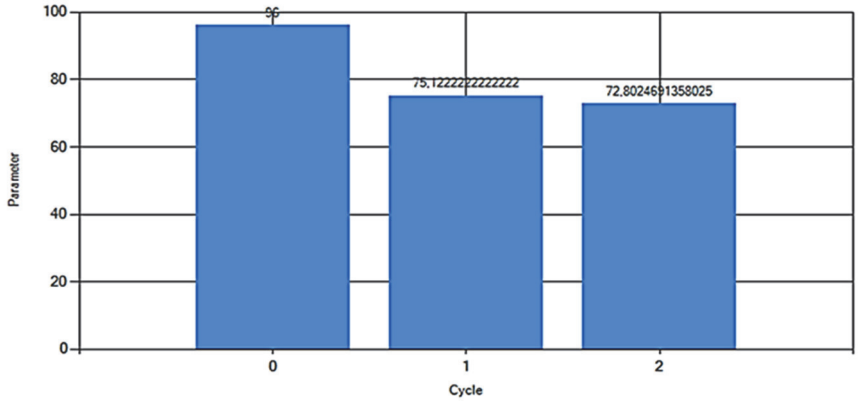


Figure 5.5 Improvement of home ownership ratio in Estonia by using DSS-HS System

The same method gives a suggested ownership ratio for Lithuania of 73,3%, Latvia 75,1% and Spain 75,1% as seen in Figure 5.6, Figure 5.7 and Figure 5.8.

Lithuania

Approximation cycle	0	1	2
The corrected value	91,9	75,122	73,258
It is determined whether the corrected value being valuated had been calculated accurately enough	18,26%	2,48%	0,28%

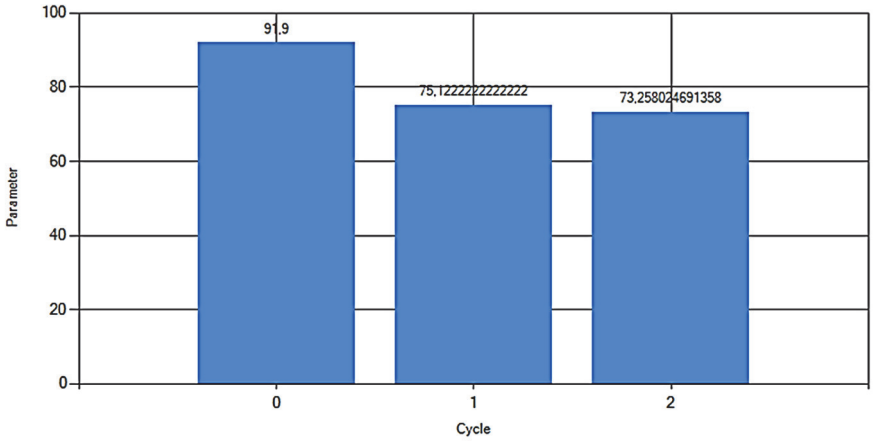


Figure 5.6 Suggested home ownership ratio for Lithuania

Latvia

Approximation cycle	0	1
The corrected value	81,2	75,122
It is determined whether the corrected value being valuated had been calculated accurately enough	7,48%	0,90%

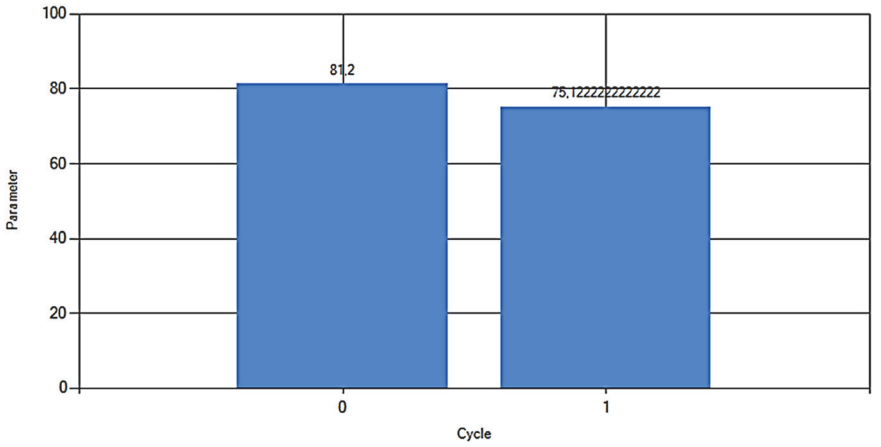


Figure 5.7 Suggested home ownership ratio for Latvia.

Spain

Approximation cycle	0	1
The corrected value	78,9	75,122
It is determined whether the corrected value being valuated had been calculated accurately enough	4,79%	0,56%

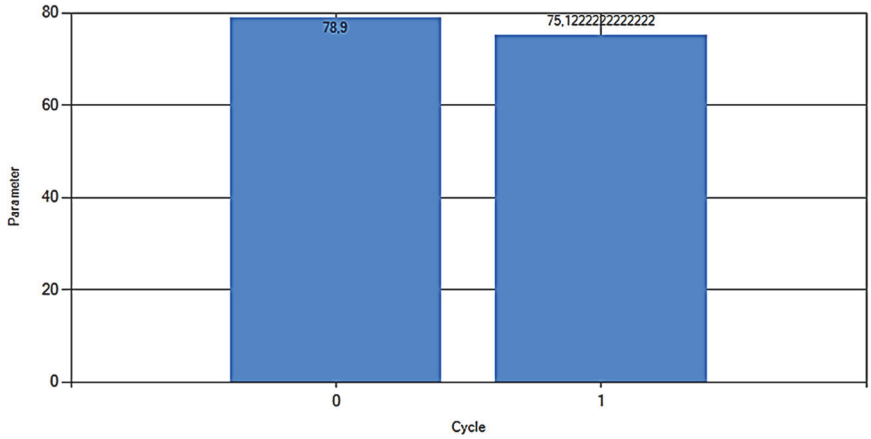


Figure 5.8 Suggested home ownership ratio for Spain.

For the other countries, no corrections are recommended and the results of the multiple criteria assessment are presented in Appendix 4.

5.5 Conclusions Based on Multiple Criteria Assessment

In order to perform multiple criteria assessment of the sustainability of the housing market, six groups of criteria were proposed, namely:

- general economic,
- housing stock,
- housing affordability,
- population and social conditions,
- housing quality, and
- environmental quality indicators.

Housing markets of nine European countries with different backgrounds (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Spain, Sweden and UK) were compared.

According to the income diversity and justification by the multiple criteria assessment, an economically sustainable share of home ownership for Estonia would be approximately 72,8%. Housing policies should be aimed to assist social housing and the rental sector which act as buffers for those who have lost their homes or do not qualify for mortgage loans.

The multiple criteria assessment methodology and the DSS-HS system developed can be adapted to different regions and cities, as unemployment rate, income and area per resident vary. It provides a valuable tool to assess the sustainability of housing in different regions and to revise policies so that every resident can live in a decent home.

The results of the research are published in *Land Use Policy* „Comparison of housing market sustainability in European countries based on multiple criteria assessment“ *(Nuuter et al., 2015)*.

5.6 Practical Application for Three Estonian Counties

For practical application of the model, three Estonian counties were chosen as shown in Figure 5.9:

- Läänemaa, the Western region,
- Ida-Virumaa, the Eastern region and
- Viljandimaa as Southern region.

Figure 5.9 Estonian counties compared.

Unfortunately, not much data is available for counties in Estonia. General economic indicators, housing quality and social criteria was partly found from the statistics *(Statistics_Estonia, 2014)* and partly calculated by the author. GDP was calculated as a percentage. The number of dwellings and social rental dwellings per 1000 inhabitants was calculated.

The initial data for calculations is presented in Table 5.2.

Table 5.2 : Initial data for Estonian Counties

Indicators	Estonia	Ida-Virumaa	Läänemaa	Viljandimaa
GDP per capita in PPS , % of EST		8,2	1,2	2,4
Unemployment rate, %	10,2	17,2	10,4	7,1
Inflation rate, %	4,2	4,2	4,2	4,2
Total dwelling stock (*1000)	651	86	15	26
Number of dwelling per 1000 inh.	485	562	614	537
Private ownership (% of total housing stock)	96,0	95,7	95,5	95.5
Social rental stock as % of total housing stock	1	1	1	1
Number of social rental dwellings per 1000 inhabitants	5	44	3	15
Share of housing cost in disposable income (%)	19,1	23,1	15,6	18,2
Population at risk of poverty or social exclusion (%)	23,4	30,0	22,0	13,0
Average household size	2,2	2,0	2,0	2,0

For a more accurate assessment, data from residential construction, housing loans, population with severe housing deprivation, housing overcrowding rate, nominal house price to disposable income as well as some environmental should be provided by the statistics agency on a regional basis.

In comparison with previously calculated Estonian indicators, general economic and social indicators revealed, that Viljandimaa ranked as second (utility degree 46,8%), Läänemaa third (utility degree 29,4%) and Ida-Virumaa last (utility degree 25,0%).Calculation results are presented in Table 5.3.

Table 5.3: Calculation results of Estonian counties compared

County	Estonia total	Läänemaa	Viljandimaa	Ida-Virumaa
Ranking, all groups /utility degree %	1 / 100	4 / 47,1	2 / 57,2	3 / 49,4
General economic and social indicators /utility degree %	1 / 100	3 / 29,5	2 / 46,8	4 / 25,0
Housing indicators /utility degree %	1 / 100	4 / 76,8	3 / 79,7	2 / 93,8

Housing indicators revealed that the best situation is in Ida-Virumaa (utility degree 93,7%),which is understandable, as many families have left the region searching for jobs. The result can also be misleading to some extent as there are many deteriorated and empty dwellings.

Viljandimaa and Läänemaa had similar utility degrees correspondingly 79,7% and 76,8 %.

Results of general calculations ranked Viljandimaa second (utility degree 57,2%, Ida–Virumaa third (utility degree 49,4%) and Läänemaa fourth (utility degree 47,1%). The results imply that the housing markets in the selected counties are less sustainable and the need for improvement is greater than in Estonia on average.

These results give some insight, but it is evident that multiple criteria analysis is applicable for all the cities and regions of Estonia. Criteria could be modified according to the aims of decision makers, but local authorities should co-operate in data collection.

Calculations of general economic, social and housing indicators are presented in Figure 5.10, general calculations in Figure 5.11.

General economic and social indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives					
		Units	Weight	Compared alternatives			
				Estonia general	Ida Virumaa	Läänemaa	Viljandimaa
GDP per capita in PPS (EU28=100)	+	%	0,4	0,3578	0,0293	0,0043	0,0086
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Unemployment rate	-	%	0,3	0,0683	0,1145	0,0696	0,0475
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population at risk of poverty or social exclusion	-	%	0,3	0,0794	0,1018	0,0747	0,0441
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing				0,3578	0,0293	0,0043	0,0036
The sums of weighted normalized minimizing				0,1477	0,2163	0,1443	0,0916
Significance of the alternative				0,4967	0,1241	0,1465	0,2326
Priority of the alternative				1	4	3	2
Utility degree of the alternative (%)				100	24,99	29,49	46,82

Housing indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives					
		Units	Weight	Compared alternatives			
				Estonia general	Ida Virumaa	Läänemaa	Viljandimaa
Total dwelling stock	+	number*1000	0,1	0,0837	0,0111	0,0019	0,0033
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of dwellings per 1000 inhab	+	Number per	0,1	0,0221	0,0256	0,0279	0,0244
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Private ownership rate as indicator of shortage of affordable (rental)	-	%	0,3	0,0753	0,075	0,0749	0,0749
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Social rental stock as % of total housing stock	+	%	0,1	0,025	0,025	0,025	0,025
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of social rental dwellings per 1000 inhab.	+	Number per	0,1	0,0075	0,0657	0,0045	0,0244
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Share of housing costs in disposable income	-	%	0,2	0,0503	0,0608	0,0411	0,0479
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Average household size	-	Number of	0,1	0,0268	0,0244	0,0244	0,0244
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing				0,4961	0,1567	0,0636	0,0837
The sums of weighted normalized minimizing				0,3001	0,3765	0,2847	0,2388
Significance of the alternative				0,7882	0,3896	0,3715	0,4508
Priority of the alternative				1	3	4	2
Utility degree of the alternative (%)				99,99	49,43	47,13	57,19

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

Figure 5.10. Calculations of general economic, social and housing indicators

General calculations

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives					
		Units	Weight	Compared alternatives			
				Estonia general	Ida Virumaa	Läänemaa	Viljandimaa
GDP per capita in PPS (EU28=100)	+	%	0.4	0,3578	0,0293	0,0043	0,0086
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Unemployment rate	0	%	0,3	0,0683	0,1145	0,0696	0,0475
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population at risk of poverty or social exclusion	-	%	0,3	0,0794	0,1018	0,0747	0,0441
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total dwelling stock	-	number*1000	0,1	0,0837	0,0111	0,0019	0,0033
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of dwellings per 1000 inhab	-	number*1000	0,1	0,0217	0,0267	0,0405	0,0152
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Private ownership rate as indicator of shortage of affordable (rental)	-	%	0,3	0,0753	0,075	0,0749	0,0749
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Social rental stock as % of total housing stock	+	%	0,1	0,025	0,025	0,025	0,025
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of social rental dwellings per 1000 inhab	+	%	0,1	0,0075	0,0657	0,0045	0,0244
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Share of housing costs in disposable income	-	%	0,2	0,0503	0,0608	0,0411	0,0479
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
Average household size	-	Number of	0,1	0,0268	0,0244	0,0244	0,0244
				AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing				0,4961	0,1567	0,0636	0,0837
The sums of weighted normalized minimizing				0,3001	0,3765	0,2847	0,2388
Significance of the alternative				0,7882	0,3896	0,3715	0,4508
Priority of the alternative				1	3	4	2
Utility degree of the alternative (%)				99,99	49,43	47,13	57,19

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

Figure 5.11 General sustainability calculations of three Estonian counties.

6. Recommended Policies and Conclusions

The policies and research described in the literature review are mostly concerned with housing bubbles and economic fluctuations (loan to value ratios and income multiples, to help the borrowers understand the risk they face in the housing market, taxes on second properties, property tax in transition countries).

Housing market intervention to assist low-income populations is, to some extent, introduced in all the compared countries. In the Baltic States, the public assistance is mostly in the form of demand-side subsidies.

Public housing is classified as supply-side intervention. However, such programmes will also affect the situation of others through the effects upon market equilibrium. But these programmes increase affordablity and are justified to assist residents with health problems, elderly people, single mothers, etc. Labour mobility and community cohesion could also be improved by social housing developments. Housing assistance for low-income households provided through public housing still tends to increase the overall stock of housing. *The housing stock of Estonia is in desperate need of refurbisment and growth.*

According to the MCAM - Multiple Criteria Assessment Model and DSS-HS - Decision Support System for Housing Sustainability Assessment elaborated in this research *there is an urgent need to improve sustainability of the Estonian housing market (and those of the other Baltic States).*

The principal choices for the government are to lead the country to economic prosperity or to *increase the share of (public) rental housing*. In the current, politically fragile situation, the economic prosperity of any European country in the near future is highly doubtful.

It is up to the government to decide *how to create a rental sector: public housing or non-profit landlords or to assist private landlords.* In any case, sub-letting mostly representing the shadow economy, does not solve the problem. Problems with sub-letting do not guarantee the security of tenants and sometimes of owners too. Unfortunate outcomes of sub-letting in the UK were emotionally presented by Layton *(Layton, 2014)*.

Based on our findings we can conclude:

1. Multiple criteria analysis and comparison of nine European countries revealed that housing markets with high home ownership ratio in Estonia, Latvia and Lithuania are not sustainable and consistent with general economic indicators.

2. An excessive home ownership ratio does not allow the achievement of the five paradigms of housing, especially in a country with moderate economic development. Housing as home concerns privileges affecting safety, freedom, and privacy that are fulfilled with an excessive home ownership rate, but this ownership proved not to be sustainable for all homeowners.Housing as a human right is fulfilled partially, as housing as an economic good is not affordable for the lower income groups, as well as access to and tenure in safe and decent housing. Diversity of income and, correspondingly, of the housing stock, does

not always guarantee social order and massive developments in the outskirts of cities may not be the best land use. From the social point of view, social housing and affordable rental units are the only way to assist residents with lower social status. Housing as an economic good proved to suit those in the upper quintiles of incomes. Substantial gains are regurarly made and lost in the housing markets. Debates about housing affordability are carried out within this paradigm as homeowners with low income are extremely vulnerable at the period of economic downturn and unemployment.

3. Owner-occupied housing is not affordable for almost half of Estonian residents. Though Estonia is small, regional differences are considerable. Every city and county has different problems. The system developed allows the ranking of all the regions according to the sustainability of the housing market on the precondition that statistical data will be available.

4. There is an evident need to present more data for the country and on a regional basis, to harmonize rules for data gathering and processing. The most important issue for real estate and construction market analysis and for reliable research results is to create a data collection system for construction cost.

5. The calculations revealed that to increase sustainability of the Estonian housing market, total dwelling stock and social rental stock should be increased. It is up to the authorities to decide how to provide public housing, but the need to increase the affordable rental sector is evident.

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Appendix 1: Initial Data for Calculations

General economic indicators

Criteria describing the alternatives	*	Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
GDP per capita in PPS (EU28=100)	+	%	0,4	69	70	70	97	115	129	125	122	110
Unemployment rate	-	%	0,3	10,2	13,3	14,9	25	7,7	8	7,5	5,5	7,9
Inflation rate	-	%	0,3	4,2	3,2	2,3	2,4	3,2	0,9	2,4	2,1	2,8

Housing stock indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Total dwelling stock	+	number * 1000	0,1	651	1 308	1 042	25 129	2 784	4 508	2 608	39 268	27 108
Number of dwellings per 1000 inhab	+	Number per 1000 inhab	0,1	485	390	461	544	531	479	500	490	443
Private ownership rate as indicator of shortage of affordable (rental) housing	-	%	0,3	96,0	91,9	81,2	78,9	73,9	69,9	64,3	53,3	66,7
Social rental stock as % of total housing stock	+	%	0,2	1,0	3,0	0,4	2,0	16,0	18,0	19,0	4,6	18,0
Number of social rental dwellings per 1000 inhab.	+	Number per 1000 inhab	0,2	5,0	11,7	4,2	10,9	85,0	84,0	95,0	22,6	80,0
Residential Construction in % GDP	+	%	0,1	3,5	1,8	1,9	5,2	6,7	3,2	4,2	5,8	3,3

Housing affordability indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Total housing cost in Purchasing Power Standards (PPS)	-	PPS	0,1	201,9	187,1	192,2	357,7	415,6	541,6	693	671,1	489,9
Share of housing costs in disposable income	-	%	0,05	19,1	20,1	21,7	21,6	17,9	23	30,1	27,9	19,8
Representative Interest Rates on New Residential Loans	-	%	0,05	2,89	2,97	3,66	2	1,97	3,54	3,67	3,07	3,69
Housing cost overburden rate (as % of population)	-	% of population	0,1	7,9	8,9	11,2	14,3	4,5	9	17,8	16,6	7,4
Nominal House Price to Disposable Income of Households Ratio (2006=100)	-	%	0,1	56,4	58,3	65,4	71,5	93,7	88,7	72,1	95,9	104
Harmonised index of consumers price in housing (2005=100), 2012 M12	-	%	0,1	183,06	190,37	209,62	141,49	133,61	120,96	125,8	120,7	148,6
Total Outstanding Residential Loans to GDP Ratio	-	%	0,05	34,4	17,9	24,2	61,1	44,4	80,7	100,8	44,8	81
Total Outstanding Residential Debt to Disposable Income of Households Ratio	-	%	0,05	64,3	30,2	40	94,7	72,9	156,5	205,7	66,2	119,1
General government expenditures for housing and community ammendments	+	% GDP	0,1	0,6	0,3	1,3	0,6	0,6	0,7	0,4	6	0,9
Aggregated affordability index	+	Index	0,2	0,97	0,53	1,27	1,43	1,79	1,67	2,3	2,61	1,93
Nominal House Prices Indices (2006=100)	-	Index	0,1	75,3	78,3	87,7	76,9	120,7	124,1	85,1	108,7	109,3

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

Population and social conditions

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Inequality of income distribution S80/S20 income quintile share ratio	-	Index	0,2	2,9	3,4	3,7	4,1	3,3	3,4	3,1	3,9	4,2
Population at risk of poverty or social exclusion	-	%	0,2	23,4	32,5	36,6	28,2	17,2	18,2	19	19,6	24,1
Population with severe housing deprivation	+	%	0,3	72	70,3	59,7	85,1	89,2	87,2	78,2	83,4	78,6
Real adjusted gross disposable income of households per capita	+	PPS	0,3	11 567	13 864	7 927	18 439	22 867	22 808	21 154	25 914	21 474

Housing quality indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Housing overcrowding rate	-	%	0,2	15,5	21,7	40,3	6	3,6	9,2	6,7	5,5	7
Average household size	-	Number of people	0,2	2,2	2,3	2,5	2,6	2,1	2,1	1,9	2	2,3
Average useful floor area per person	+	m2	0,6	30	28,9	27	35	38,9	40	65	55	33

Environmental quality indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Health care index	+	Index	0,1	78,06	70,79	71,38	75,61	76,41	78,7	86,13	73,25	71,28
Traffic Index	-	Index	0,1	48,59	59,81	60,3	65,89	162,67	60,12	55,3	74,55	114,88
Noise from neighbours or from the street	-	% of population	0,1	12,8	13,3	15,4	15	14,2	13	17,5	26,1	18,2
Pollution, grime or other environmental problems	-	% of population	0,2	11,9	14,6	22,2	8	8,8	7,6	5,7	22,4	8,3
Crime, violence or vandalism in the area	-	Index	0,2	15,7	5	17,2	10,1	8,6	9,6	10,3	12,5	19,7
Quality of Life Index	+	Index	0,3	154,94	114,05	122,18	141,05	167,21	191,36	182,29	204,84	148,14

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

Appendix 2: Multiple Criteria Calculations Using COPRAS Method

General economic indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives									
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
GDP per capita in PPS (EU28=100)	+	%	0,4	0,0304	0,0309	0,0309	0,0428	0,0507	0,0569	0,0551	0,0538	0,0485
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Unemployment rate	-	%	0,3	0,0306	0,0399	0,0447	0,075	0,0231	0,024	0,0225	0,0165	0,0237
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Inflation rate	-	%	0,3	0,0536	0,0409	0,0294	0,0306	0,0409	0,0115	0,0306	0,0268	0,0357
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,0304	0,0309	0,0309	0,0428	0,0507	0,0569	0,0551	0,0538	0,0485
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0842	0,0808	0,0741	0,1056	0,064	0,0355	0,0531	0,0433	0,0594
Significance of the alternative				0,078	0,0805	0,085	0,0807	0,1133	0,1697	0,1305	0,1463	0,1159
Priority of the alternative				9	8	6	7	5	1	3	2	4
Utility degree of the alternative (%)				0,4594	0,4741	0,5005	0,4756	0,6674	1	0,769	0,862	0,683

Housing stock indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives									
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Total dwelling stock	+	number*1 000	0,1	0,0006	0,0013	0,001	0,0241	0,0027	0,0043	0,0025	0,0376	0,026
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of dwellings per 1000 inhab	+	Number per 1000 inhab	0,1	0,0112	0,009	0,0107	0,0126	0,0123	0,0111	0,0116	0,0113	0,0102
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Private ownership rate as indicator of shortage of	-	%	0,3	0,0426	0,0408	0,036	0,035	0,0328	0,031	0,0285	0,0237	0,0296
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Social rental stock as % of total housing stock	+	%	0,2	0,0024	0,0073	0,001	0,0049	0,039	0,0439	0,0463	0,0112	0,0439
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of social rental dwellings per 1000 inhab.	+	Number per 1000 inhab	0,2	0,0025	0,0059	0,0021	0,0055	0,0427	0,0422	0,0477	0,0113	0,0402
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Residential Construction in % GDP	+	%	0,1	0,0098	0,0051	0,0053	0,0146	0,0188	0,009	0,0118	0,0163	0,0093
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,0265	0,0286	0,0201	0,0617	0,1155	0,1105	0,1199	0,0877	0,1296
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0426	0,0408	0,036	0,035	0,0328	0,031	0,0285	0,0237	0,0296
Significance of the alternative				0,0518	0,055	0,0501	0,0925	0,1484	0,1453	0,1577	0,1332	0,166
Priority of the alternative				8	7	9	6	3	4	2	5	1
Utility degree of the alternative (%)				0,3121	0,3315	0,3015	0,5572	0,8937	0,8751	0,9501	0,8023	1

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

Housing affordability indicators

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Total housing cost in Purchasing Power Standards	-	PPS	0,1	0,0054	0,005	0,0051	0,0095	0,0111	0,0144	0,0185	0,0179	0,0131
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Share of housing costs in disposable income	-	%	0,05	0,0047	0,005	0,0054	0,0054	0,0044	0,0057	0,0075	0,0069	0,0049
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Representative Interest Rates on New Residential Loans	-	%	0,05	0,0053	0,0054	0,0067	0,0036	0,0036	0,0064	0,0067	0,0056	0,0067
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Housing cost overburden rate (as % of population)	-	% of population	0,1	0,0081	0,0091	0,0115	0,0147	0,0046	0,0092	0,0182	0,017	0,0076
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Nominal House Price to Disposable Income of	-	%	0,1	0,008	0,0083	0,0093	0,0101	0,0133	0,0126	0,0102	0,0136	0,0147
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Harmonised index of consumers price in housing	-	%	0,1	0,0133	0,0139	0,0153	0,0103	0,0097	0,0088	0,0092	0,0088	0,0108
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total Outstanding Residential Loans to GDP	-	%	0,05	0,0035	0,0018	0,0025	0,0062	0,0045	0,0082	0,0103	0,0046	0,0083
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total Outstanding Residential Debt to	-	%	0,05	0,0038	0,0018	0,0024	0,0056	0,0043	0,0092	0,0121	0,0039	0,007
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
General government expenditures for housing	+	%GDP	0,1	0,0053	0,0026	0,0114	0,0053	0,0053	0,0061	0,0035	0,0526	0,0079
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Aggregated affordability index	+	Index	0,2	0,0134	0,0073	0,0175	0,0197	0,0247	0,023	0,0317	0,036	0,0266
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Nominal House Prices Indices (2006=100)	-	Index	0,1	0,0087	0,009	0,0101	0,0089	0,0139	0,0143	0,0098	0,0126	0,0126
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,0187	0,0099	0,0289	0,025	0,03	0,0291	0,0352	0,0886	0,0345
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0608	0,0593	0,0683	0,0743	0,0694	0,0888	0,1025	0,0909	0,0857
Significance of the alternative				0,115	0,1087	0,1147	0,1038	0,1144	0,0951	0,0923	0,153	0,1028
Priority of the alternative				**2**	**5**	**3**	**6**	**4**	**8**	**9**	**1**	**7**
Utility degree of the alternative (%)				0,7517	0,7101	0,7492	0,6785	0,7475	0,6212	0,6034	1	0,672

Population and social conditions

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Inequality of income distribution S80/S20 income	-	Index	0,2	0,0181	0,0213	0,0231	0,0256	0,0206	0,0213	0,0194	0,0244	0,0263
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population at risk of poverty or social exclusion	-	%	0,2	0,0214	0,0297	0,0335	0,0258	0,0157	0,0166	0,0174	0,0179	0,022
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population with severe housing deprivation	+	%	0,3	0,0307	0,03	0,0255	0,0363	0,038	0,0372	0,0333	0,0356	0,0335
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Real adjusted gross disposable income of	+	PPS	0,3	0,0209	0,0251	0,0143	0,0333	0,0413	0,0412	0,0382	0,0468	0,0388
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,0516	0,0551	0,0398	0,0696	0,0793	0,0784	0,0715	0,0824	0,0723
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0395	0,051	0,0566	0,0514	0,0363	0,0379	0,0368	0,0423	0,0483
Significance of the alternative				0,1004	0,0929	0,0739	0,1071	0,1324	0,1293	0,1239	0,128	0,1122
Priority of the alternative				**7**	**8**	**9**	**6**	**1**	**2**	**4**	**3**	**5**
Utility degree of the alternative (%)				0,7583	0,7016	0,5578	0,8089	1	0,9763	0,9356	0,9665	0,8475

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

Housing quality indicators

Criteria describing the alternatives	*	Units	Weight	Quantitive and qualitative information pertinent to alternatives								
				Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Housing overcrowding rate	-	%	0,2	0,0268	0,0376	0,0698	0,0104	0,0062	0,0159	0,0116	0,0095	0,0121
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Average household size	-	Number of people	0,2	0,022	0,023	0,025	0,026	0,021	0,021	0,019	0,02	0,023
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Average useful floor area per person	+	m2	0,6	0,051	0,0491	0,0459	0,0595	0,0662	0,068	0,1105	0,0935	0,0561
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,051	0,0491	0,0459	0,0595	0,0662	0,068	0,1105	0,0935	0,0561
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0488	0,0606	0,0948	0,0364	0,0272	0,0369	0,0306	0,0295	0,0351
Significance of the alternative				0,086	0,0773	0,0639	0,1065	0,129	0,1143	0,1664	0,1514	0,1048
Priority of the alternative				**7**	**8**	**9**	**5**	**3**	**4**	**1**	**2**	**6**
Utility degree of the alternative (%)				0,5171	0,4647	0,3843	0,6399	0,7757	0,6872	1	0,9103	0,63

Environmental quality indicators

Criteria describing the alternatives	*	Units	Weight	Quantitive and qualitative information pertinent to alternatives								
				Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Health care index	+	Index	0,1	0,0115	0,0104	0,0105	0,0111	0,0112	0,0115	0,0126	0,0107	0,0105
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Traffic Index	-	Index	0,1	0,0069	0,0085	0,0086	0,0094	0,0232	0,0086	0,0079	0,0106	0,0164
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Noise from neighbours or from the street	-	% of population	0,1	0,0088	0,0091	0,0106	0,0103	0,0098	0,0089	0,012	0,0179	0,0125
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Pollution, grime or other environmental problems	-	% of population	0,2	0,0217	0,0267	0,0405	0,0146	0,0161	0,0139	0,0104	0,0409	0,0152
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Crime, violence or vandalism in the area	-	Index	0,2	0,0289	0,0092	0,0316	0,0186	0,0158	0,0177	0,019	0,023	0,0362
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Quality of Life Index	+	Index	0,3	0,0326	0,024	0,0257	0,0297	0,0352	0,0403	0,0383	0,0431	0,0312
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,0441	0,0344	0,0362	0,0408	0,0464	0,0518	0,0509	0,0538	0,0417
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,0663	0,0535	0,0913	0,0529	0,0649	0,0491	0,0493	0,0924	0,0803
Significance of the alternative				0,1074	0,1128	0,0822	0,1201	0,1111	0,1373	0,136	0,0992	0,094
Priority of the alternative				**6**	**4**	**9**	**3**	**5**	**1**	**2**	**7**	**8**
Utility degree of the alternative (%)				0,7824	0,822	0,5986	0,8751	0,8091	1	0,9909	0,7228	0,6845

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

General calculations

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives										
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
GDP per capita in PPS (EU28=100)	+	%	0,4	0,0304	0,0309	0,0309	0,0428	0,0507	0,0569	0,0551	0,0538	0,0485
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Unemployment rate	-	%	0,3	0,0306	0,0399	0,0447	0,075	0,0231	0,024	0,0225	0,0165	0,0237
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Inflation rate	-	%	0,3	0,0536	0,0409	0,0294	0,0306	0,0409	0,0115	0,0306	0,0268	0,0357
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total dwelling stock	+	number*1 000	0,1	0,0006	0,0013	0,001	0,0241	0,0027	0,0043	0,0025	0,0376	0,026
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of dwellings per 1000 inhab	+	Number per 1000	0,1	0,0112	0,009	0,0107	0,0126	0,0123	0,0111	0,0116	0,0113	0,0102
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Private ownership rate as indicator of shortage of	-	%	0,3	0,0426	0,0408	0,036	0,035	0,0328	0,031	0,0285	0,0237	0,0296
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Social rental stock as % of total housing stock	+	%	0,2	0,0024	0,0073	0,001	0,0049	0,039	0,0439	0,0463	0,0112	0,0439
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Number of social rental dwellings per 1000 inhab.	+	Number per 1000	0,2	0,0025	0,0059	0,0021	0,0055	0,0427	0,0422	0,0477	0,0113	0,0402
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Residential Construction in % GDP	+	%	0,1	0,0098	0,0051	0,0053	0,0146	0,0188	0,009	0,0118	0,0163	0,0093
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total housing cost in Purchasing Power Standards	-	PPS	0,1	0,0054	0,005	0,0051	0,0095	0,0111	0,0144	0,0185	0,0179	0,0131
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Share of housing costs in disposable income	-	%	0,05	0,0047	0,005	0,0054	0,0054	0,0044	0,0057	0,0075	0,0069	0,0049
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Representative Interest Rates on New Residential Loans	-	%	0,05	0,0053	0,0054	0,0067	0,0036	0,0036	0,0064	0,0067	0,0056	0,0067
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Housing cost overburden rate (as % of population)	-	% of population	0,1	0,0081	0,0091	0,0115	0,0147	0,0046	0,0092	0,0182	0,017	0,0076
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Nominal House Price to Disposable Income of	-	%	0,1	0,008	0,0083	0,0093	0,0101	0,0133	0,0126	0,0102	0,0136	0,0147
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Harmonised index of consumers price in housing	-	%	0,1	0,0133	0,0139	0,0153	0,0103	0,0097	0,0088	0,0092	0,0088	0,0108
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total Outstanding Residential Loans to GDP	-	%	0,05	0,0035	0,0018	0,0025	0,0062	0,0045	0,0082	0,0103	0,0046	0,0083
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Total Outstanding Residential Debt to	-	%	0,05	0,0038	0,0018	0,0024	0,0056	0,0043	0,0092	0,0121	0,0039	0,007
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
General government expenditures for housing	+	%GDP	0,1	0,0053	0,0026	0,0114	0,0053	0,0053	0,0061	0,0035	0,0526	0,0079
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Aggregated affordability index	+	Index	0,2	0,0134	0,0073	0,0175	0,0197	0,0247	0,023	0,0317	0,036	0,0266
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Nominal House Prices Indices (2006=100)	-	Index	0,1	0,0087	0,009	0,0101	0,0089	0,0139	0,0143	0,0098	0,0126	0,0126
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Inequality of income distribution S80/S20 income	-	Index	0,2	0,0181	0,0213	0,0231	0,0256	0,0206	0,0213	0,0194	0,0244	0,0263
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population at risk of poverty or social exclusion	-	%	0,2	0,0214	0,0297	0,0335	0,0258	0,0157	0,0166	0,0174	0,0179	0,022
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Population with severe housing deprivation	+	%	0,3	0,0307	0,03	0,0255	0,0363	0,038	0,0372	0,0333	0,0356	0,0335
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Real adjusted gross disposable income of	+	PPS	0,3	0,0209	0,0251	0,0143	0,0333	0,0413	0,0412	0,0382	0,0468	0,0388
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Housing overcrowding rate	-	%	0,2	0,0268	0,0376	0,0698	0,0104	0,0062	0,0159	0,0116	0,0095	0,0121
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Average household size	-	Number of people	0,2	0,022	0,023	0,025	0,026	0,021	0,021	0,019	0,02	0,023
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN

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

General calculations (continuation)

Criteria describing the alternatives	*	Quantitive and qualitative information pertinent to alternatives									
		Units	Weight	Compared alternatives								
				Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Average useful floor area per person	+	m2	0,6	0,051	0,0491	0,0459	0,0595	0,0662	0,068	0,1105	0,0935	0,0561
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Health care index	+	Index	0,1	0,0115	0,0104	0,0105	0,0111	0,0112	0,0115	0,0126	0,0107	0,0105
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Traffic Index	-	Index	0,1	0,0069	0,0085	0,0086	0,0094	0,0232	0,0086	0,0079	0,0106	0,0164
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Noise from neighbours or from the street	-	% of population	0,1	0,0088	0,0091	0,0106	0,0103	0,0098	0,0089	0,012	0,0179	0,0125
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Pollution, grime or other environmental problems	-	% of population	0,2	0,0217	0,0267	0,0405	0,0146	0,0161	0,0139	0,0104	0,0409	0,0152
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Crime, violence or vandalism in the area	-	Index	0,2	0,0289	0,0092	0,0316	0,0186	0,0158	0,0177	0,019	0,023	0,0362
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
Quality of Life Index	+	Index	0,3	0,0326	0,024	0,0257	0,0297	0,0352	0,0403	0,0383	0,0431	0,0312
				AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN	AVG MIN
The sums of weighted normalized maximizing (projects 'pluses') indices of the alternative				0,2223	0,208	0,2018	0,2994	0,3881	0,3947	0,4431	0,4598	0,3827
The sums of weighted normalized minimizing (projects 'minuses') indices of the alternative				0,3422	0,346	0,4211	0,3556	0,2946	0,2792	0,3008	0,3221	0,3384
Significance of the alternative				0,5427	0,5249	0,4622	0,6078	0,7603	0,7874	0,8076	0,8002	0,7067
Priority of the alternative				7	8	9	6	4	3	1	2	5
Utility degree of the alternative (%)				0,672	0,6499	0,5723	0,7526	0,9414	0,975	1	0,9908	0,875

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

Appendix 3: TOP 3 Criteria with Greatest Influence on Ranking

General economic indicators

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
GDP per capita in PPS (EU28=100)	Position	1	1	1	3	3	2	3	2	3
	Possible improvement of the analysed criterion in %	86,96%	84,29%	84,29%	32,99%	12,17%	0,00%	3,20%	5,74%	17,27%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	34,78%	33,71%	33,71%	13,20%	4,87%	0,00%	1,28%	2,30%	6,91%
Inflation rate	Position	2	2	2	2	1		1	1	1
	Possible improvement of the analysed criterion in %	78,57%	71,88%	63,09%	62,50%	71,88%	0,00%	62,50%	57,14%	67,86%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	23,57%	21,56%	18,93%	18,75%	21,56%	0,00%	18,75%	17,14%	20,36%
Un-employment rate	Position	3	3	3	1	2	1	2		2
	Possible improvement of the analysed criterion in %	46,08%	58,65%	60,87%	78,00%	28,57%	31,25%	26,67%	0,00%	30,38%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	13,82%	17,59%	18,26%	23,40%	8,57%	9,38%	8,00%	0,00%	9,11%

Housing stock indicators

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Total dwelling stock	Position	1	1	3		1	1	1		3
	Possible improvement of the analysed criterion in %	5931,95%	2902,14%	3668,52%		1310,49%	771,07%	1405,67%		44,86%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	593,20%	290,21%	366,85%		131,05%	77,11%	140,57%		4,49%
Social rental stock as % of total housing stock	Position	2	3	1	1	3			2	
	Possible improvement of the analysed criterion in %	1800%	533,33%	4650%	850%	18,75%			313,04%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	360%	106,67%	930%	170%	3,75%			62,61%	
Number of social rental dwellings per 1000 inhab.	Position	3	2	2	2				1	
	Possible improvement of the analysed criterion in %	1800%	711,97%	2183,65%	771,56%				320,35%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	360%	142,39%	436,73%	154,31%				64,07%	
Private ownership rate as indicator of shortage of affordable (rental) housing	Position				3	2	3	3		2
	Possible improvement of the analysed criterion in %				32,45%	27,88%	23,75%	17,11%		20,09%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion				9,73%	8,36%	7,12%	5,13%		6,03%
Residential Construction in % GDP	Position						2	2	3	1
	Possible improvement of the analysed criterion in %						109,38%	59,52%	15,52%	103,03%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion						10,94%	5,95%	1,55%	10,30%

Housing affordability indicators

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
General government expenditures for housing and community ammendments	Position	1	1	1	1	1	1	1		1
	Possible improvement of the analysed criterion in %	900%	1900%	361,54%	900%	757,14%	757,14%	1400%		566,67%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	90%	190%	36,15%	90%	75,71%	75,71%	140%		56,67%
Aggregated affordability index	Position	2	2	2	2	2	2			2
	Possible improvement of the analysed criterion in %	169,07%	392,45%	105,51%	82,52%	56,29%	56,29%			35,23%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	33,81%	78,49%	21,10%	16,50%	11,26%	11,26%			7,05%
Housing cost overburden rate (as % of population)	Position	3	3	3	3			2	1	
	Possible improvement of the analysed criterion in %	43,04%	49,44%	59,82%	68,53%			74,72%	72,89%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	4,30%	4,94%	5,98%	6,85%			7,47%	7,29%	
Total housing cost in Purchasing Power Standards (PPS)	Position					3	3	3	2	3
	Possible improvement of the analysed criterion in %					65,45%	65,45%	73%	72,12%	61,81%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion					6,55%	6,55%	7,30%	7,21%	6,18%
Nominal House Price to Disposable Income of Households Ratio (2006=100)	Position								3	
	Possible improvement of the analysed criterion in %								41,19%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion								4,12%	

Population and social conditions

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Real adjusted gross disposable income of households per capita	Position	1	1	1	1	1	1	1		1
	Possible improvement of the analysed criterion in %	124,03%	86,92%	226,91%	40,54%	13,32%	13,62%	22,50%		20,68%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	37,21%	26,07%	68,07%	12,16%	4,00%	4,09%	6,75%		6,20%
Population with severe housing deprivation	Position	2	3	2				2	3	
	Possible improvement of the analysed criterion in %	23,89%	26,88%	49,41%				14,07%	6,95%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	7,17%	8,07%	14,82%				4,22%	2,09%	
Population at risk of poverty or social exclusion	Position	3	2	3	2		3	3	2	3
	Possible improvement of the analysed criterion in %	26,50%	47,08%	53,01%	39,01%		5,49%	9,47%	12,24%	28,63%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	5,30%	9,42%	10,60%	7,80%		1,10%	1,89%	2,45%	5,73%
Inequality of income distribution S80/S20 income quintile share	Position				3	2	2		1	2
	Possible improvement of the analysed criterion in %				29,27%	12,12%	14,71%		25,64%	30,95%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion				5,85%	2,42%	2,94%		5,13%	6,19%

Housing quality indicators

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Average useful floor area per person	Position	1	1	1	1	1	1		1	1
	Possible improvement of the analysed criterion in %	116,67%	124,91%	140,74%	85,71%	67,10%	62,50%		18,18%	96,97%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	70%	74,95%	84,44%	51,43%	40,26%	37,50%		10,91%	58,18%
Housing overcrowding rate	Position	2	2	2	2	3	2	1	2	2
	Possible improvement of the analysed criterion in %	76,77%	83,41%	91,07%	40%	0%	60,87%	46,27%	34,55%	48,57%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	15,35%	16,68%	18,21%	8%	0%	12,17%	9,25%	6,91%	9,71%
Average household size	Position	3	3	3	3	2	3		3	3
	Possible improvement of the analysed criterion in %	13,64%	17,39%	24%	26,92%	9,52%	9,52%		5%	17,39%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	2,73%	3,48%	4,80%	5,38%	1,90%	1,90%		1%	3,48%

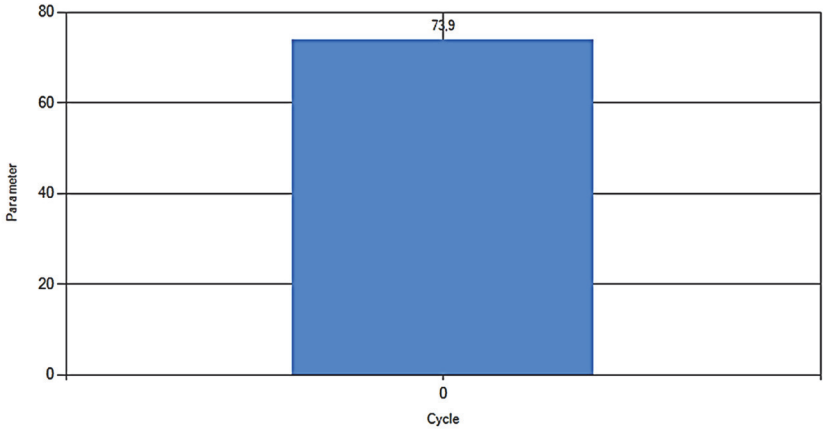
Environmental quality indicators

Criteria describing the alternatives		Estonia	Lithuania	Latvia	Spain	Finland	Sweden	Denmark	Germany	UK
Crime, violence or vandalism in the area	Position	1		3	2	1	1	1	2	1
	Possible improvement of the analysed criterion in %	68,15%		70,93%	50,50%	41,86%	47,92%	51,46%	60%	74,62%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	13,63%		14,19%	10,10%	8,37%	9,58%	10,29%	12%	14,92%
Pollution, grime or other environmental problems	Position	2	2	2	3	2	2		1	3
	Possible improvement of the analysed criterion in %	52,10%	60,96%	74,32%	28,75%	35,23%	25%		74,55%	31,33%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	10,42%	12,19%	14,86%	5,75%	7,05%	5%		14,91%	6,27%
Quality of Life Index	Position	3	1	1	1		3	2		2
	Possible improvement of the analysed criterion in %	32,21%	79,61%	67,65%	45,23%		7,04%	12,37%		31,33%
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion	9,66%	23,88%	20,30%	13,57%		2,11%	3,71%		6,27%
Health care index	Position		3							
	Possible improvement of the analysed criterion in %		21,67%							
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion		2,17%							
Traffic index	Position					3				
	Possible improvement of the analysed criterion in %					70,13%				
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion					7,01%				
Noise from neighbours or from the street	Position							3	3	
	Possible improvement of the analysed criterion in %							26,86%	50,96%	
	Possible increase of the market value of the alternative in % through increased value of the aforementioned criterion							2,69%	5,10%	

Appendix 4: Ownership Ratios for Other Countries

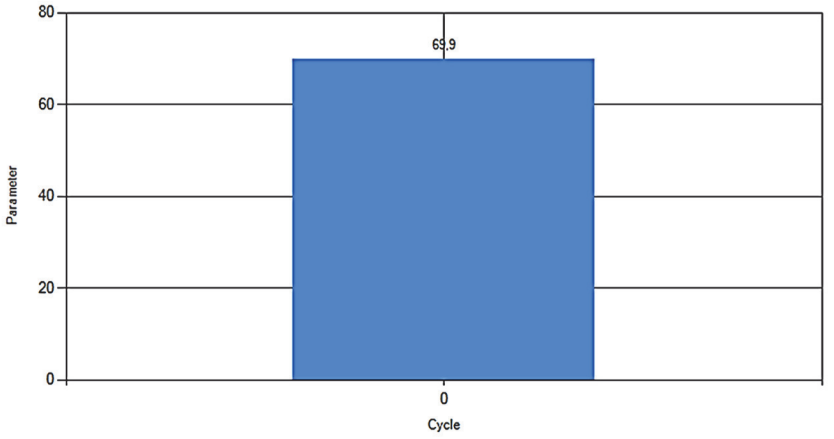
Finland

Approximation cycle	0
The corrected value	73,9
It is determined whether the corrected value being valuated had been calculated accurately enough	-1,65%



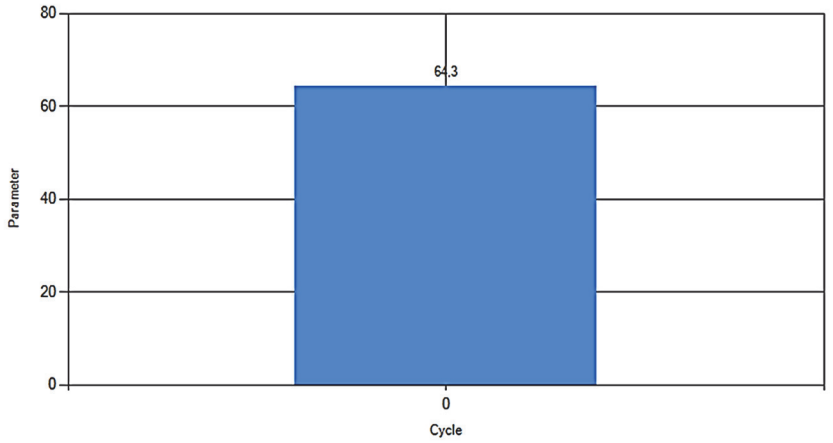
Sweden

Approximation cycle	0
The corrected value	69,9
It is determined whether the corrected value being valuated had been calculated accurately enough	-7,47%



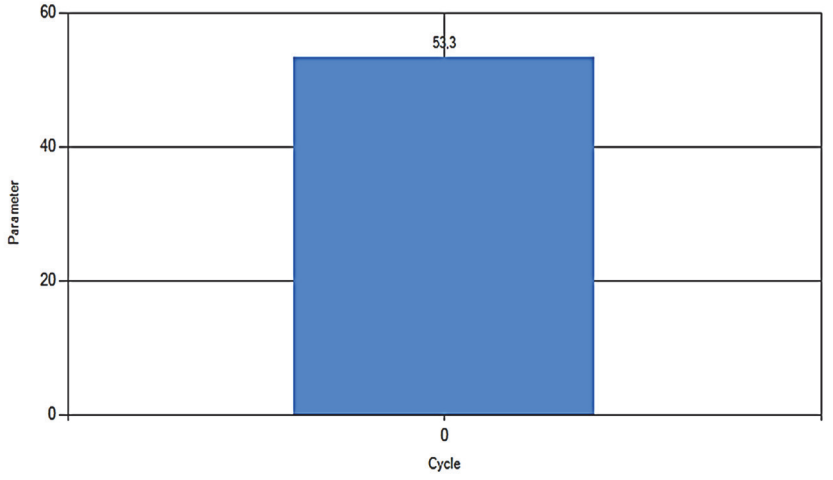
Denmark

Approximation cycle	0
The corrected value	64,3
It is determined whether the corrected value being valuated had been calculated accurately enough	-16,83%



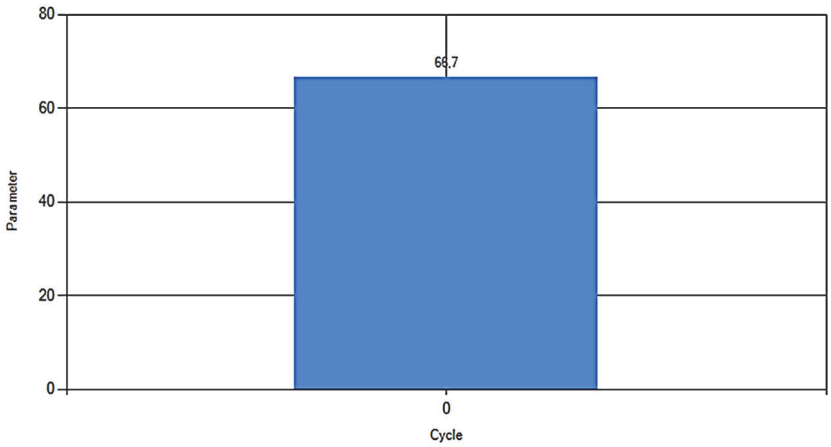
Germany

Approximation cycle	0
The corrected value	53,3
It is determined whether the corrected value being valuated had been calculated accurately enough	-40,94%



UK

Approximation cycle	0
The corrected value	66,7
It is determined whether the corrected value being valuated had been calculated accurately enough	-12,63%



Abstract

The dissertation investigates the sustainability of housing markets in selected European countries, gives insights into the development of the Estonian housing market (which has an excessive home ownership ratio) and assesses the affordability of housing for different income groups.

The dissertation consists of an Introduction, 4 Sections, Conclusions, References, 4 Annexes, List of Publications and Curriculum Vitae.

The introduction describes the investigated problem, the research methods and strategy, the focus and scope of the research, the contribution of the dissertation and the outline of the dissertation.

Section 2 reviews the related scientific literature. The literature review is divided into four subsections – different approaches to housing policy, housing and macroeconomic development, housing affordability and sustainability and overview of the housing market models recently applied.

Section 3 presents problems specific to a country with a high home ownership ratio. This section explains the development path from public renters to home-owners, the problems of construction and the housing market, affordability for different income groups, housing policy in Estonia and problems with the available data.

Section 4 describes the MCAM – Multiple Criteria Assessment Model.

The model and components of the Decision Support System DSS-HS are described and the system of criteria is developed. The use of the COPRAS method is reasoned.

Section 5 presents a case study in which the sustainability of the housing markets of nine countries is compared. Countries representing high ownership ratios - Estonia, Latvia, Lithuania and Spain were compared with developed countries having mature housing markets - the UK, Denmark, Germany, Finland and Sweden.

Application of the MCAM model to assess the sustainability of the housing markets in three Estonian counties is presented and suggestions to improve the situation are drawn in the conclusion of the chapter.

Conclusions include that a high home ownership ratio is not consistent with economic development of the countries. The suggested home ownership ratios are given for the Baltic States and Spain along with the recognition that the housing markets in the Baltic States as well as Spain are not sustainable and there are problems with affordability by low-income households.

Keywords: excessive home ownership, housing market sustainability, diversity of incomes, MCAM – Multiple Criteria Assessment Model, DSS-HS - Decision Support System for Housing Sustainability Assessment.

Kokkuvõte

Hulgikriteeriumide simultaananalüüsi mudel eluasemeturu jätkusuutlikkuse hindamiseks

Sissejuhatus

Väitekirjas uuritakse, kas valdavalt omandi-eluaseme turg on jätkusuutlik ja on tagatud elanike õigus kaasaegsele eluasemele, eluasemele kui kodule ja kui majandushüvele. Autor on veendunud, et õigus eluasemele tähendab ka vaba valikut soetada kas omandi-eluase või eluase üürida. Sissejuhatav osa on struktureeritud kuude alapunkti, millest esimeses esitatakse probleemi tähtsus ja taust, teises uurimismeetodid ja strateegia, kolmandas uurimustöö eesmärgid, neljandas piiritletakse uuritav valdkond, viiendas esitatakse uurimustulemuste olulisus ja kuuendas väitekirja struktuur.

Kirjanduse ülevaade

on struktureeritud nelja ossa, millest esimene käsitleb erinevate riikide ja koolkondade eluasemepoliitika suundumusi, teine vaatleb eluasemeturu ja makroökonoomiliste näitajate seoseid eesmärgiga uurida, millised näitajad on olulised eluaseme jätkusuutlikkuse hindamiseks. Vaadeldakse ka eluasemeturu heitlikkust, selle mõju majapidamistele ja majandusele. Kolmandas osas vaadeldakse eluaseme kättesaadavuse probleeme.

Neljandas osas esitatakse ülevaade eluasemeturu hindamiseks kasutatud mudelitest.

Kolmandas peatükis

kirjeldatakse olukorda kõrge omandi-eluaseme osatähtsusega riigis. Lähteolukorda hinnatakse Eesti eluasemeturu ja majandusarengu näitel. Ülevaade kajastab eluasemefondi muutumist taasiseseisvumise algusest, samuti viimase kümne aasta majandusnäitajaid. Eritähelepanu on pööratud sissetulekute erinevusele. Kui keskmise sissetulekuga perele on omandi-eluase kättesaadav, siis sissetulekute erinevus kvintiilide kaupa näitab, et reaalselt saavad seda endale lubada vaid pooled pered. Esile tuuakse ka andmebaaside puudulikkus ja ebausaldusväärsus.

Kuna Eestis ei ole andmeid eri tüüpi hoonete ehitusmaksumuse kohta ega ehituskmaksumuse kohta üldse, on kõik eluasemeturu tasakaalule rajatud majandusmudelid kaheldavad.

Neljandas peatükis

tutvustatakse hulgikriteeriumide simultaananalüüsi mudelit eluasemeturu jätkusuutlikkuse hindamiseks ning töötatakse välja kriteeriumite süsteem ja otsustussüsteem, mis võimaldab anda hinnanguid, milliseid näitajaid tuleks parendada ja milline on majanduslikult põhjendatud omandi-eluaseme osakaal.

Põhjendatakse ka COPRAS meetodi (võrdlev analüüs) valikut.

Kriteeriumid on jagatud nelja gruppi: majanduse üldnäitajad, eluaseme kätteaadavus, eluaseme kvaliteet, sotsiaalsed ja keskkonna näitajad. Määratakse kriteeriumite tähtsus ja kaalud.

Viiendas peatükis

võrreldakse Eesti, Läti, Leedu ning samuti kõrge omandi-eluaseme osatähtsusega Hispaania näitajaid arenenud Euroopa riikide, Soome, Rootsi, Taani, Saksamaa ning Ühendkuningriigi näitajatega.

Arvutuste kohaselt on kõrgeima jätkusuutlikkusega Taani eluasemeturg, järgneb Saksamaa ja Rootsi. Nendes riikides on omandi-eluaseme osatähtsus alla 70%. Kolme kõrgeima üldreitinguga riigi järjestus majanduse üldnäitajate alusel on Rootsi, Saksamaa, Taani. Taanis on ka võrreldavate riikide seas parimad eluasemefondi kvaliteedinäitajad.

Eesti on pingereas seitsmendal, Leedu kaheksandal ja Läti viimasel kohal.

Kuna süsteem võimaldab määrata tulemusi kõikides näitajate gruppides eraldi, on tulemused enam vähem sarnased kõikide gruppide osas. Esitatud on ka arvutustele põhineva soovitused, mille kohaselt majanduse üldnäitajatele ja eluaseme kättesaadavusele vastav omandi-eluaseme osatähtsus peaks olema Eestis 72,8 %, Leedus 73.3 %, Lätis 75,2 % and Hispaanias 75, 1%.

Seega ilmnes, et Eesti eluasemefond vajab täiendamist üldmahu ja sealhulgas ka sotsiaal- ja odavamate üürieluasemete kasvu arvel.

Koostatud mudelit kohaldatakse ka Eesti kolme maakonna võrdlemiseks. Valitud on geograafiliselt erinevad piirkonnad, kusjuures Viljandimaaa on valitud põhjusel, et üürieluasemete puudumine Viljandis takistab seal uute töökohtade loomist.

Arvutuste kohaselt on olukord Eesti keskmise järel parim Viljandimaal, järgneb Ida-Virumaa ja viimasel kohal on Läänemaa. Märkida tuleb, et arvutused on ligikaudsed, sest Eesti eri piirkondade kohta ei ole võimalik saada kõiki riikide võrdluses kasutatud andmeid. Siiski võib hinnata, et valitud maakondade eluasemeturu olukord on tunduvalt halvem Eesti keskmisest. Majandus- ja sotsiaalnäitajate osakaal on 25,0 – 46,8% keskmisest. Eluasemefondi erinevus Eesti keskmisest on suhteliselt väike ning Ida-Virumaa elamufondi kõrge reiting kajastab ühest küljest elanikkonna vähenemist, kuid elamufond sisaldab ka tühjalt seisvaid lagunenud elamuid.

Põhimõtteliselt on süsteemi abil võimalik järjestada kõik Eesti linnad ja maakonnad, kuid selleks tuleb eelnevalt täiendada statistilist arvestust.

Kuuendas peatükis

esitatakse kokkuvõte ja soovitused, et Eestis on vaja täiendavat sotsiaalelamufondi ning toimivat üürisektorit. Kas seda korraldavad valitsuse volitusel kohalikud omavalitsused, mittetulundusühingud või toetatakse üürimajade omanikke, tuleb otsustada vastavalt piirkondlikule eripärale. Koostatud mudeli kohaselt on ilmne, et probleemi ei ole võimalik lahendada peamiselt varimajandusliku omandi-korterite väljaüürimisega.

List of Publications

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Curriculum Vitae

Tiina Nuuter

Birth date & place: 02 April 1950, Tallinn, Estonia
Contact: tiina.nuuter@ttu.ee
Education: Economist - TTU, 1974

Language competence:

Estonian	fluent
English	fluent
Finnish	medium
Russian	fluent

Professional employment:

1991-2014 TUT associate professor, lecturer
1982-91 State Design Institute "Eesti projekt" Construction Chief Economist
1970-91 Design Institute „EKE Project“ Senior Engineer

Academic degree: Master of Technical Science – TTU, 2000

Honours/awards:

2000 - Edict of Rector of Tallinn University of Technology
2000 - Rae grant

Main areas of scientific work/research topics:

housing market, real estate economics

Participation in the projects

ANDROID - Academic Network for Disaster Resilience to Optimise Educational Development; CADRE - Collaborative action towards disaster resilience education ; CASCADE- Collaborative action towards societal challenges through awareness, development and education; CENEAST-Reformation of the Curricula on Built Environment in the Eastern Neighbouring Area; DIGIEDU - Digital Processes for Education and Management of Construction ; Estonian-Finnish Real Estate development and Training Project etc.

Elulookirjeldus

Tiina Nuuter

Sünniaeg ja -koht: 02.April 1950, Tallinn
Kontakt: tiina.nuuter@ttu.ee
Haridus: Ökonomist - TTÜ, 1974

Keeleoskus:

Eesti keel	kõrgtase
Inglise keel	kõrgtase
Soome keel	kesktase
Vene keel	kõrgtase

Teenistuskäik:
1991-2014 TTÜ dotsent, lektor
1982-91 RPI "Eesti projekt" peaehitusökonomist
1970-91 PI „EKE Projekt“ vaneminsener

Teaduskraad: Tehnikateaduste magister – TTÜ, 2000

Tunnustused:
2000 – TTÜ Rektori käskkiri
2000 - Rae grant

Teadustöö põhisuunad: eluasemeturg, kinnisvara ökonoomika

DISSERTATIONS DEFENDED AT TALLINN UNIVERSITY OF TECHNOLOGY ON *CIVIL ENGINEERING*

1. **Heino Mölder**. Cycle of Investigations to Improve the Efficiency and Reliability of Activated Sludge Process in Sewage Treatment Plants. 1992.

2. **Stellian Grabko**. Structure and Properties of Oil-Shale Portland Cement Concrete. 1993.

3. **Kent Arvidsson**. Analysis of Interacting Systems of Shear Walls, Coupled Shear Walls and Frames in Multi-Storey Buildings. 1996.

4. **Andrus Aavik**. Methodical Basis for the Evaluation of Pavement Structural Strength in Estonian Pavement Management System (EPMS). 2003.

5. **Priit Vilba**. Unstiffened Welded Thin-Walled Metal Girder under Uniform Loading. 2003.

6. **Irene Lill.** Evaluation of Labour Management Strategies in Construction. 2004.

7. **Juhan Idnurm**. Discrete Analysis of Cable-Supported Bridges. 2004.

8. **Arvo Iital**. Monitoring of Surface Water Quality in Small Agricultural Watersheds. Methodology and Optimization of monitoring Network. 2005.

9. **Liis Sipelgas**. Application of Satellite Data for Monitoring the Marine Environment. 2006.

10. **Ott Koppel**. Infrastruktuuri arvestus vertikaalselt integreeritud raudtee-ettevõtja korral: hinnakujunduse aspekt (Eesti peamise raudtee-ettevõtja näitel). 2006.

11. **Targo Kalamees**. Hygrothermal Criteria for Design and Simulation of Buildings. 2006.

12. **Raido Puust**. Probabilistic Leak Detection in Pipe Networks Using the SCEM-UA Algorithm. 2007.

13. **Sergei Zub**. Combined Treatment of Sulfate-Rich Molasses Wastewater from Yeast Industry. Technology Optimization. 2007.

14. **Alvina Reihan**. Analysis of Long-Term River Runoff Trends and Climate Change Impact on Water Resources in Estonia. 2008.

15. **Ain Valdmann**. On the Coastal Zone Management of the City of Tallinn under Natural and Anthropogenic Pressure. 2008.

16. **Ira Didenkulova**. Long Wave Dynamics in the Coastal Zone. 2008.

17. **Alvar Toode**. DHW Consumption, Consumption Profiles and Their Influence on Dimensioning of a District Heating Network. 2008.

18. **Annely Kuu**. Biological Diversity of Agricultural Soils in Estonia. 2008.

19. **Andres Tolli**. Hiina konteinerveod läbi Eesti Venemaale ja Hiinasse tagasisaadetavate tühjade konteinerite arvu vähendamise võimalused. 2008.

20. **Heiki Onton**. Investigation of the Causes of Deterioration of Old Reinforced Concrete Constructions and Possibilities of Their Restoration. 2008.

21. **Harri Moora**. Life Cycle Assessment as a Decision Support Tool for System optimisation – the Case of Waste Management in Estonia. 2009.

22. **Andres Kask**. Lithohydrodynamic Processes in the Tallinn Bay Area. 2009.

23. **Loreta Kelpšaitė**. Changing Properties of Wind Waves and Vessel Wakes on the Eastern Coast of the Baltic Sea. 2009.

24. **Dmitry Kurennoy.** Analysis of the Properties of Fast Ferry Wakes in the Context of Coastal Management. 2009.

25. **Egon Kivi**. Structural Behavior of Cable-Stayed Suspension Bridge Structure. 2009.

26. **Madis Ratassepp**. Wave Scattering at Discontinuities in Plates and Pipes. 2010.

27. **Tiia Pedusaar**. Management of Lake Ülemiste, a Drinking Water Reservoir. 2010.

28. **Karin Pachel**. Water Resources, Sustainable Use and Integrated Management in Estonia. 2010.

29. **Andrus Räämet**. Spatio-Temporal Variability of the Baltic Sea Wave Fields. 2010.

30. **Alar Just**. Structural Fire Design of Timber Frame Assemblies Insulated by Glass Wool and Covered by Gypsum Plasterboards. 2010.

31. **Toomas Liiv**. Experimental Analysis of Boundary Layer Dynamics in Plunging Breaking Wave. 2011.

32. **Martti Kiisa**. Discrete Analysis of Single-Pylon Suspension Bridges. 2011.

33. **Ivar Annus**. Development of Accelerating Pipe Flow Starting from Rest. 2011.

34. **Emlyn D. Q. Witt**. Risk Transfer and Construction Project Delivery Efficiency – Implications for Public Private Partnerships. 2012.

35. **Oxana Kurkina**. Nonlinear Dynamics of Internal Gravity Waves in Shallow Seas. 2012.

36. **Allan Hani**. Investigation of Energy Efficiency in Buildings and HVAC Systems. 2012.

37. **Tiina Hain**. Characteristics of Portland Cements for Sulfate and Weather Resistant Concrete. 2012.

38. **Dmitri Loginov**. Autonomous Design Systems (ADS) in HVAC Field. Synergetics-Based Approach. 2012.

39. **Kati Kõrbe Kaare**. Performance Measurement for the Road Network: Conceptual Approach and Technologies for Estonia. 2013.

40. **Viktoria Voronova**. Assessment of Environmental Impacts of Landfilling and Alternatives for Management of Municipal Solid Waste. 2013.

41. **Joonas Vaabel**. Hydraulic Power Capacity of Water Supply Systems. 2013.

42. **Inga Zaitseva-Pärnaste**. Wave Climate and its Decadal Changes in the Baltic Sea Derived from Visual Observations. 2013.

43. **Bert Viikmäe**. Optimising Fairways in the Gulf of Finland Using Patterns of Surface Currents. 2014.

44. **Raili Niine**. Population Equivalence Based Discharge Criteria of Wastewater Treatment Plants in Estonia. 2014.

45. **Marika Eik**. Orientation of Short Steel Fibers in Cocrete. Measuring and Modelling. 2014.

46. **Maija Viška**. Sediment Transport Patterns Along the Eastern Coasts of the Baltic Sea. 2014.

47. **Jana Põldnurk**. Integrated Economic and Environmental Impact Assessment and Optimisation of the Municipal Waste Management Model in Rural Area by Case of Harju County Municipalities in Estonia. 2014.

48. **Nicole Delpeche-Ellmann**. Circulation Patterns in the Gulf of Finland Applied to Environmental Management of Marine Protected Areas. 2014.