VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

VERSLO VADYBOS FAKULTETAS

FINANSŲ INŽINERIJOS KATEDRA

Milda Šedytė

EVALUATION OF SUPPLEMENTARY PENSION FUNDS USING MULTI-CRITERIA EVALUATION MODEL: LITHUANIAN CASE

SAVANORIŠKŲJŲ PENSIJŲ FONDŲ ĮVERTINIMAS LIETUVOS PAVYZDŽIU, NAUDOJANT MULTI KRITERIJŲ VERTINIMO MODELĮ

Baigiamasis magistro darbas

Verslo vadybos studijų programa, valstybinis kodas 62403S121

Investicijų valdymo specializacija

Vadybos ir verslo administravimo studijų kryptis

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Trumpai pristatyti Lietuvos pensijų sistemą, išanalizuoti ir pristatyti savanoriškųjų pensijų fondų rinką. Išanalizuti literatūros šaltiniuose siųlomus pensijų fondų vertinimo metodus ir modelius. Apibūdintis pagrindines jų charakteristikas bei skirtumus. Remiantis išnagrinėtomi metodikomis bei egzistuojančiais multi kriterijų vertinimo ir sprendimo modeliais, sukurti savanoriškųjų pensijų vertinimo modelį, leidžiantį individualiam investuotojui įvertinti savanorškuosius pensijų fondus pagal jo individualius pageidavimus bei iššskiriantį jam labiausiai tinkamus pensijų fondus. Aprobuoti sukurtą modelį, įvertinant Lietuvoje veikiančius savanoriškuosius pensijų fondus, pateikti išvadas ir pasiūlymus.

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Kitų asmenų indėlio į parengtą baigiamąjį darbą (projektą) nėra. Jokių įstatymų nenumatytų piniginių sumų už šį darbą niekam nesu mokėjęs(-usi).

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Verslo vadybos studijų programos baigiamasis magistro darbas

Pavadinimas **Savanoriškųjų pensijų fondų vertinimas Lietuvos pavyzdžiu, naudojant multi kriterijų sprendimo modelį**

Autorius **Milda Šedytė** Vadovas doc. dr. **Jelena Stankevičienė**

Kalba
[ ] lietuvių
[X] užsienio

Anotacija

Baigiamajame magistro darbe nagrinėjama savanoriškųjų pensijų fondų vertinimo problematika Lietuvoje. Darbo tikslas yra įvertinti Lietuvos savanoriškuosius pensijų fondus, atsižvelgiant į reliatyvaus individualaus investuotojo poreikius, naudojant sukurtą multi kriterijų sprendimo modelį, bei nustatyti pensijų fondą geriausiai atitinkantį investuotojo poreikius. Šiam tikslui pasiekti teorinėje darbo dalyje nagrinėjami literatūros šaltiniuose aprašyti pensijų fondų vertinimo modeliai bei metodikos. Remiantis šiomis metodikomis bei egzistuojančiais multi kriterijų vertinimo modeliais, pensijų fondų vertinimui adaptuojamas kombinuotas AHP ir GRA modelis bei apibūdinamas jo veikimo principas. Mokslinio tyrimo dalyje išanalizuojami ir pasirenkami savanoriškųjų pensijų fondų vertinimo kriterijai, jiems apskaičiuojami svertiniai koeficientai, atsižvelgiant į jų reikšmingumą reliatyviam individualiam investuotojui. Nustatomi ryšiai tarp pensijų fondų rodiklių. Naudojant sukurtąjį vertinimo modelį, patikrinamas jo pritaikomumas Lietuvos savanoriškiesiems pensijų fondams. Tai įgyvendinama visapusiškai vertinant ir lyginant savanoriškuosius pensijų fondus atrinktais kriterijais. Šis modelis leidžia vertitnti pensijų fondus tiek kokybiniais tiek kiekybiniais kriterijais, atsižvelgia į investuotojo norus bei poreikius.

Darbą sudaro 7 dalys: įvadas; ankstesni moksliniai tyrimai; AHP ir GRA modelis; Lietuvos pensijų fondų sistema bei savanoriškųjų pensijų fondų rinkos analizė; Lietuvos savanoriškųjų pensijų fondų įvertinimas; išvados; literatūros ir internetinių šaltinių sąrašas.

Darbo apimtis – 86 p. teksto be priedų, 8 iliustr., 38 lent., 87 bibliografiniai šaltiniai.

Atskirai pridedami darbo priedai

Prasminiai žodžiai: savanoriškieji pensijų fondai, vertinimo modelis, pensijų fondų vertinimo kriterijai, veiklos vertinimas, investavimas, AHP, GRA.

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Title: **Evaluation of supplementary pension funds using multi-criteria decision model: Lithuanian case**

Author **Milda Šedvtė** Academic supervisor **doc. Dr. Jelena Stankevičienė**

Thesis language

[ ] Lithuanian

[X] Foreign (English)

Annotation

In the final master thesis, supplementary pension funds valuation issues in Lithuania are analyzed. Goal of the thesis is to evaluate Lithuanian supplementary pension funds using the composed multi-criteria decision model, taking into account the preferences of a relative individual investor, and to determine the pension fund best suited for investor‘s needs. To reach this goal, in the theoretical part of the thesis, literature sources of pension funds valuation models and methodologies are analyzed. Based on these methodologies and existing multi criteria evaluation models, combined AHP and GRA model is adapted for pension funds evaluation and it‘s operation principle is described. In the scientific research part of the thesis, supplementary pension funds evaluation criteria are analyzed and selected, weighted coefficients are calculated according to the significance given to them by the relative individual investor. Relations between pension funds‘ criteria data are identified. By using the composed evaluation model, its applicability is tested for Lithuanian supplementary pension funds. It is done by thoroughly evaluating and comparing selected criteria of supplementary pension funds. This model allows for evaluation of the pension funds by qualitative and quantitative criteria, takes into account investor‘s preferences.

Structure: introduction, previous research, AHP and GRA model, Lithuanian pension funds system and supplementary pension funds market analysis, evaluation of Lithuanian supplementary pension funds, conclusions and suggestions, references.

Thesis consist of: 86 p. text without appendixes, 8 pictures, 38 tables, 87 bibliographical entries.

Appendixes included.

Keywords: supplementary pension funds, evaluation model, pension funds evaluation criteria, performance evaluation, investment, AHP, GRA.

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TABLES, FIGURES

INTRODUCTION

Securing the future is an important topic. For this reason many decide to participate in supplementary pension funds. One reason for this is that pension funds offer risk pooling for small investors, providing a better trade-off of risk and return than for direct holdings. What is more, they offer the ability to absorb and process information, superior to that of individual investors in the capital market. Lastly, pension funds are of large size and thus can use economies of scale, which result in lower average costs for investors. Investors share the costly services of expert investment managers and thereby save in advisory fees. Knowing all the benefits of supplementary pension funds the hardest part is to choose the best one. Every one of them has to be evaluated in order to single out the better ones.

The novelty in this work is that the new supplementary pension funds evaluation model is created. The model evaluates pension funds from relative investors perspective and considers both their financial performance and overall attraction. It is based on a multi-criteria decision strategy combining two models: Analytical Hierarchy Process (AHP) and Grey Relational Analysis (GRA) and using their advantages to combine, find relations and evaluate to help make decisions when using both: qualitative and quantitative criteria. In this paper the general AHP and GRA model framework is adopted to suit specifically supplementary pension funds. It is composed in such a way that can be used by simple individual investor having information available to the public to evaluate the fund's performance and make the decision on their own.

The actuality of the theme investigated and the main reason of choosing this subject became the growing essentiality of choosing the right supplementary pension fund to invest money for the future. In the real life the investment process of choosing supplementary pension fund is quite complicated; in addition to risk and return many other factors have to be considered. Because different investors face different constraints in their investment decisions, a pension fund that is universally optimal may be impossible to find. Investors are left to their own judgments.

What is more, it can be said that there are no appropriate methodologies in Lithuania created to evaluate the best supplementary pension fund according individual investors preferences. It is not quite clear what criterion are the most important and should be considered when choosing. Still there is no methodology known to public that would allow an investor to evaluate and choose the pension fund. In our society the concept of investment as financial instrument is not yet complete. Further the investment culture is not as advanced.

There are models and criterions offered in the literature for evaluating financial intermediaries. But the problem is that there is no one way or model to do that especially the one that could be easy to use for a simple investor.

The main goal of the work is to evaluate Lithuanian supplementary pension funds using the supplementary pension funds evaluation model and then according the evaluation results choose the most suitable pension fund for the relative individual investor.

The main goal of the work can be achieved by setting the following **objectives**:

1. To research the pension fund evaluation methods offered in literature.
2. To set up the multi-criteria decision model based on AHP and GRA.
3. To review Lithuanian pension structure and conditions and trends in supplementary pension funds market.
4. To test the models applicability and to evaluate Lithuanian supplementary pension funds.

The methods of analyses, which were used, is comparison of opinions of authors stated in financial articles, grouping and interpreting scientific literature sources, graphical and table data representation, model development, and data analysis.

The subject of the work is actual both in practical and theoretical sense.

1. This work can be useful as a guide-model for individual investors who are thinking of choosing supplementary pension fund as type of investment, and
2. For pension fund manager companies to compare their performance to other pension funds in order to make improvements.
3. Theorists investigating the evaluation and selection methods for pension funds, searching to find the optimal model.

The work is composed of four main parts. The first part investigates the previous research of pension funds evaluation and selection problem. As a result the chronological order of changes and different models shall be composed. The second part indicates the need for such an evaluation and selection model and later defines the general AHP and GRA model by identifying the strengths of these two models individually and then combining them together to make a step by step evaluation and selection framework that will be used in the fourth part of this paper. Third part introduces the Lithuanian pension system and supplementary pension funds market. That is done in order to understand where in the whole supplementary pension funds stand and to see if the trends of the market shall be reflected in the choice offered by the results of the evaluation using the composed model. In the fourth part, the practical part of the paper, on the basis of theory and a model composed, the evaluation of Lithuanian supplementary pension funds is made. The results are presented and then the most suitable supplementary pension fund for the relative individual investor is recommended.

1. PREVIOUS RESEARCH

In the first chapter it is intended to review the previous research on ways of evaluating the performance of pension funds. The research on pension funds evaluation from individual investors perspective has been scares, but in this work it is tried to review all research concerning evaluation and selection techniques in order to see how they contribute to the evaluation model chosen in this paper.

More known attempts to methodize the evaluation process and define certain methods for pension fund evaluation were suggested by Dietz (1965) and McCandlish (1965). Dietz presented a method for evaluating the investment performance of pension funds from the point of view of the corporate financial manager. The model suggested to evaluate performance on the basis of: (1) over-all rate of return, (2) volatility of return, a proxy for risk, (3) selection of specific securities in the various segments of the portfolio, and (4) timing of investment decisions between fixed and variable return securities. And in his paper 'Evaluating the investment performance of noninsured pension funds' argued that the widely used method of measuring performance, simply by return, is insufficient where objectives vary as widely as they may in pension fund investing. This was thought of as a method by which financial managers could evaluate their pension fund's investment performance with others on a sound theoretical and practical basis.

McCandlish in his paper 'Some methods for measuring performance of a pension fund' (1965) also looked form the point of view of corporate investor and basically this was applied to the US market He suggested these points to consider: (1) compound rate of return, (2) income on income (but it was rarely applied due to difficulties in calculation), (3) Average return, (4) trend of value (measured in terms of fund markets values), (5) equivalents (comparison to certain benchmark). When deciding which method to use one should consider utility, practicality and consistency. The final test of performance was the comparison of one with another. According to him - in spite of disparate characteristics, the performance of one pension fund can most usefully be compared with the performance of another. But this was criticized by Dietz (1966) that McCandlish did not apply the three standards (utility, practicality, consistency) to all proposed evaluation methods. What is more, Dietz indicates that McCandlish did not show why he gave most value to rate of return.

Bower and Williamson (1966) have criticized methods suggested by both above authors. The conclusions they made are these: two measures for evaluating pension fund performance, income on income and trend of value, were dismissed as unneeded and misleading. Two other measures, compound rate of return and average return, have definite faults when used to judge

pension fund managers. And a measure of weighted return was offered as a more suitable for comparative evaluation of management.

Lorie James H. (1968) has discussed the guidelines formed by NABAC (National Association for Bank Audit Control). And these were actually the first steps towards a global evaluation of pension fund. As it included, not only evaluation of pension funds financial and investment performance, but also other factors. Defined the rules of calculation of rate of return (still this is one of the main indicators of the financial performance). Discussed the importance of estimating risk (this in later years lead to many models and rations defining the relationship between risk and return) and the attitude towards risk. Suggested to compare all pension funds to a benchmark and not only to one another, suggested classification according to criteria such as: size, growth, age, contractual arrangements between trustor and trustee.

Voorheis Frank L. (1970) made a research of evaluation of pension fund investment performance. He used four basic criteria and factors: 1) fund size, 2) rate of return, 3) bank size, 4) portfolio turnover rates, in addition to investment performance (rate of return). His study showed that the larger funds, which were typically managed by the larger institutions, tended to employ more aggressive and imaginative investment policies than smaller-sized funds, but uncovered no evidence indicating that higher investment returns resulted. This finding raises some doubt as to whether the enormous concentration of reserves of retirement programs in the large banks can be justified on the basis of investment performance. Same criteria were suggested by Ippolito and Turner (1987).

Ambachtsheer, Capelle and Scheibelhut (1998) concluded that a good metric for a pension fund's organization performance must be based on a standardized calculation that adjusts the gross asset return for operating costs and risks undertaken. Such metrics have been calculated for an increasing number of pension funds in the past few years. The metrics are called "risk-adjusted net value added" (RANVA). Separate RANVAs result from the asset mix decision and from how it is implemented. They considered 1) size and passive proportion. As their previous research uncovered a statistically significant positive association between RANVA and two fund characteristics fund size and proportion of the fund passively managed. 2) Adding organization factors (such as size,) and their relation to RANVA.

Brown (1997) present studies using CAPM-based measures of performance to reflect the absolute and risk adjusted rates of return earned through the investment of pooled fund assets. Thus, he assumed an almost perfectly elastic demand for primary securities, and rely upon informationally efficient securities markets comprising representative investors with homogenous expectations (Brennan, 1993). However, Klumpes and McCrae (1999) argue that these conditions are unlikely to be satisfied by pension funds. Pension fund members themselves are typically financially

unsophisticated and normally delegate the financial management of pension funds to either an appointed corporate trustee company or to a group of individual employee or employer nominated trustee representatives. Inelasticity may arise through the agency benefits attached to appointing intermediaries of high 'reputation' that are not captured by CAPM based, return maximization frameworks.

Several indexes can be utilized to evaluate the performance of investments of pension funds, with the most traditional being the indexes developed by Jensen (1968) and Treynor (1966) (which are both based on the Capital Asset Pricing Model (CAPM)), Sharpe (1966) and the measures of selectivity and market timing, proposed by Treynor and Mazuy (1966) and Brinson, Hood and Beebower (1986). More recently, the M-2 indexes of Modigliani and Modigliani (1997) have emerged, along with the M-3, proposed by Muralidhar (2000), which is an extension of the M-2. The investment performance of the pension funds was evaluated through measures proposed by Jensen (1968) and Sharpe (1966) in paper of Baima Francisco de Resende (2005). They were used to utilize regressions between measures of performance, expenses and size that allowed for establishing the relationships among those three factors. According to Baima, the evaluation of investment performance is an important field of research, since performance can validate the investment policies and strategies of institutional investors, as well as act as an indicator as to the existence or not of an efficient market according to the consistent long-term performance of active managers.

Barrientos and Boussofiane (2005) analyzed Chilean pension funds management companies with the use of a two stage procedure. In the first stage, they calculate DEA-CCR and DEA-BCC efficiency scores, and, in the second stage, they regress the efficiency scores obtained in the first stage on contextual variables. The inputs and outputs used in the DEA stage were based on the production approach used in banking (Ferrier and Lovell, 1990). The authors used two outputs: total revenue and the number of contributors, and three inputs: marketing and sales costs, office personnel and executive pay, and administration and computing costs. In the second stage, they estimate a regression of the CCRscores on a constant term, market share, sales, the ratio of contributors to affiliates, and revenue. The use of a regression model in the second stage is a caveat of this article; since the DEA literature indicates that the efficiency scores obtained in the first stage are correlated with the explanatory variables used in the second stage, so that the second-stage estimates will be inconsistent and biased (Simar and Wilson, 2000). A bootstrap procedure described by Efron (1979) is needed to overcome this problem.

Lieksnis (2009) addressed the main problems, these being: in order to determine if managers outperform a market index it is needed first to design such market index and second to establish procedure to measure risk-adjusted return results of fund managers against the index returns. Since

second level “active” pension funds in Latvia differ from classic equity mutual funds by having a substantial fixed income investment portion required by the law. So he reviewed performance evaluation methods and results for fixed income mutual funds and balanced (debt and equity) mutual funds. The final model was the combination of: performance evaluation model by Jensen (That used only one factor – market index return along with the risk-free rate in line with the classical one-factor CAPM); Carharts method (1997) (uses the 4-factor model to evaluate the performance of mutual fund managers and the persistence of any abnormal returns); chooses index, after examining several alternatives, Markit iBoxx EUR Benchmark Index for BBB corporate bonds representing the investment-grade fixed income market for euro and euro zone bonds. The index is calculated and disseminated by Deutsche Börse. The final model was specified with the OLS regression equation.

As can be seen from the review of previous research there is no one unified way, that combines many factors (combines financial and not) and gives a possibility for the individual investor to give his own preferences and weights to certain criteria and that is reasonably easy to calculate and use. Thus, for these main reasons the combined AHP and GRA model has been chosen to satisfy the goals and shall be extensively described in the second chapter.

Summing up the first chapter, the best thing to do is to draw up a table and to shortly and chronologically describe and show the evolvement and different techniques researched. The result of this is Table 1. Current understanding of private pension fund performance measurement is related to the evaluation of mutual funds that also perform active management of debt and equity securities portfolios. Most of attention has been devoted to equity mutual fund performance. Thus the research of pension fund evaluation is limited and can easily be called unmethodical and incomplete. Any further research should be creative and adopted to specification of supplementary pension funds.

Table 1: Evolution of pension fund performance evaluation methods. (Source: made by author)

Year	Author	Method
1965	Dietz Peter O.	In addition to standard measure 1) rate of return introduced 2) volatility of return, 3) selection of securities and 4) timing of investment decision. And suggested to use them together.
1965	McCandish Randolph Jr	Introduced five performance measurement methods – to chose most appropriate one. 1) Rate of return introduced 2) income on income, 3) average return, 4) trend of value, 5) equivalents. Prefers rate of return.
1966	Bower Richard S., Williamson J. Peter	Criticized methods offered by Dietz and McCandish and offered to use Weighted Return instead.
1968	Lorie James H.	Defined calculation or rate or return, considered risk and attitude toward risk and use of benchmarks, suggested criterion: size, growth, age, contractual arrangements between trustor and trustee.
1970 1987	Voorheis Frank L Ippolito Richard, Turner John	Evaluation of pension fund investment performance (rate of return). He used four other basic criteria and factors: 1) fund size, 2) rate of return, 3) bank size, 4) portfolio turnover rates
1986 1997 1998 2000	Brinson, Hood and Beebower Modigliani and Modigliani Ambachtsheer, Capelle and Scheibelhut Muralidhar	Used measures of selectivity and market timing Risk adjusted value added Used new risk adjusted measure
1997	Brown	Use of CAMP-based measures of performance to reflect the absolute and risk adjusted rates of return earned through the investment of pooled fund assets.
2005	Baima Francisco de Resende	Investigates the relationship between investment 1) expenses and 2) pension fund size with 3) investment performance. Used 4) benchmarks, 5) return on investment. Used risk/return indices.
2005	Barrientos and Boussofiane	In the first stage, calculate DEA-CCR and DEA-BCC efficiency scores (two outputs: total revenue; number of contributors, and three inputs: marketing and sales costs, office personnel, administration and computing costs). In the second stage, estimate a regression of the CCR scores on a constant term, market share, sales, the ratio of contributors to affiliates, and revenue.
2009	Lieksnis R.	Combined performance evaluation model by Jensen (used one factor – market index return along with the risk-free rate in line with the classical one-factor CAPM) and Carhart method (uses the 4-factor model to evaluate the performance of mutual fund managers and the persistence of any abnormal returns)

2. MILTI-CRITERIA DECISION AND EVALUATION MODEL

In the second chapter, firstly, the need for evaluation and selection model of supplementary pension funds is described as investment process is complicated and many factors and risks have to be considered, thus, having in mind that a framework for this choice is not defined, this makes the choice and evaluation that much more difficult. Secondly, two theoretical models (Analytic Hierarchy Process (AHP) and Grey Relational Analysis (GRA)) are introduced as the multi-criteria decision model shall be based on the combined model of these two. A step by step evaluation framework is created and ready to be adopted to Lithuanian supplementary pension funds.

2.1. Need for evaluation and selection model

It can be said that investment decision process is divided into two separate and independent processes. In one investment professionals specialize in constructing a variety of risky portfolios. In a second process, individual investors choose already complete portfolios or funds and ect. They do that based mostly on their risk tolerances. Further, finance research has, for the better part, been focusing on the first part of the investment process that is especially on identifying some risky portfolio that would be universally optimal for all investors (Saragoul and Detzler, 2002).

However, in the real life the investment process and so the process of choosing supplementary pension fund is more complicated; in addition to risk and return many other factors have to be considered. Because different investors face different constraints in their investment decisions, a pension fund that is universally optimal may be impossible to find. Investors are left to their own judgments.

What is more, it can be said that there are no appropriate methodologies in Lithuania created to evaluate the best supplementary pension fund according individual investors preferences. It is not quite clear what criterion are the most important and should be considered when choosing. Of course investor can always compare investment returns of the funds; they know that only the funds of the same risk profile can be compared. Still there is no mythology known to public that would allow an investor to evaluate and choose the pension fund. In our society the concept of investment as financial instrument is not yet complete. Further the investment culture is not as advanced as for example personal finance management traditions.

The main problems are: first, few investors have sufficient financial knowledge to input the appropriate values for the screening variables. Second, the tools do not consider the preferences of

individual investors; the tools implicitly assume that each screening variable is equally important to all investors.

Of course one can always turn to the financial adviser for the help, but that also has its own minuses, such as: if for example investor fills out a questionnaire to pinpoint the investor's risk aversion, investment horizon, investment experience, tax status, and financial status. Based on this information, the financial advisor can recommend make his recommendations. A problem with this approach is that financial advisors often have high potential liability because disgruntled investors can sue for damages if they believe they received unsuitable investment advice (Bolster, Janjigian, and Trahan 1995). Demonstrating that an investment recommendation is suitable can be difficult because arguments as to suitability are largely subjective.

For this or other reasons investor might want to do the evaluation and selection himself. Then question arises if the indicators that are stated by the pension fund managing companies (indicators that are required by law to be stated) are enough for the investor to make evaluation and selection. As a more useful tool a benchmark index could be used, but the problem with that is, that most of Lithuanian supplementary pension funds do not yet have an adequate benchmark index. And as a result most people make a decision based on emotional-psychological aspect, that is – to do as everyone else is doing. It is the case, when the quality of the pension fund is defined by its popularity. But it does not guarantee that this is the best choice. It is the individuals' readiness to seek the set profitability knowing clearly what part of an investment can be lost.

As Bernnan (1995) argued - examining the investment decision process from the individual investor's perspective is a much needed area of research. There is an important distinction - the difference between choosing the right funds for an investor and predicting which funds will have the best performance. I propose a model that assists an individual investor in evaluating all supplementary pension funds in Lithuania according to many important criteria and help make a decision.

2.2. AHP and GRA evaluation model

Analytical Hierarchy Process (AHP)

The analytic hierarchy process (further in the paper will be indicated as AHP) was developed by Thomas L Saaty in the 1970s. It is an effective decision making technique based on Multi Criteria Decision Making Methodology (MCDM). What is more, it's also a powerful

method for group decision making used in project selection. AHP is a multi-criteria decision-making approach that simplifies complex, ill-structured problems by arranging the decision factors in a hierarchical structure. It is a measurement theory that can deal with quantitative and qualitative criteria and has been applied to numerous areas such as microcomputer selection (Arbel and Seidmann 1984), budget allocation (Sinuany-Stem 1984), and project selection (Johnson and Hihn 1980), decision theory and conflict resolution (Vaidya and Kumar, 2006). A variety of financial problems have also been solved using the AHP methodology, including assignment of sovereign debt ratings (Johnson, Srinivasan, and Bolster 1990), selection of a life insurance contract (Puelz 1991), determination of an optimal portfolio mix. Also to determine investor suitability, to select among seven investment securities (Bolster; Janjigian and Trahan, 2005). The results of their study showed varying pattern of investment for the different age groups. Investigate the determinants of stock market volatility and risk premium (Kurz, Jin and Motolese, 2003), for investment portfolio selection in banking sector (Oyatoye, Okpokpo and Adekoya, 2009), create a mutual fund selection model (Saraoglu and Detzler, 2002).

In the AHP, the whole task of the decision maker(s) is made simpler by constructing a hierarchy and developing a mathematical model that generates the priority values for different criteria and sub criteria as involved in the decision-making process.

In general, the AHP methodology consists of the four major steps (Saaty, 2008):

1. Development of the hierarchical structure.

This includes steps of determining mission, selecting criterion and identifying alternatives. Basically, the levels of the hierarchy represent the goal, criteria, sub-criteria, and alternatives of the given problem. Here is the general structure in the Figure 1.

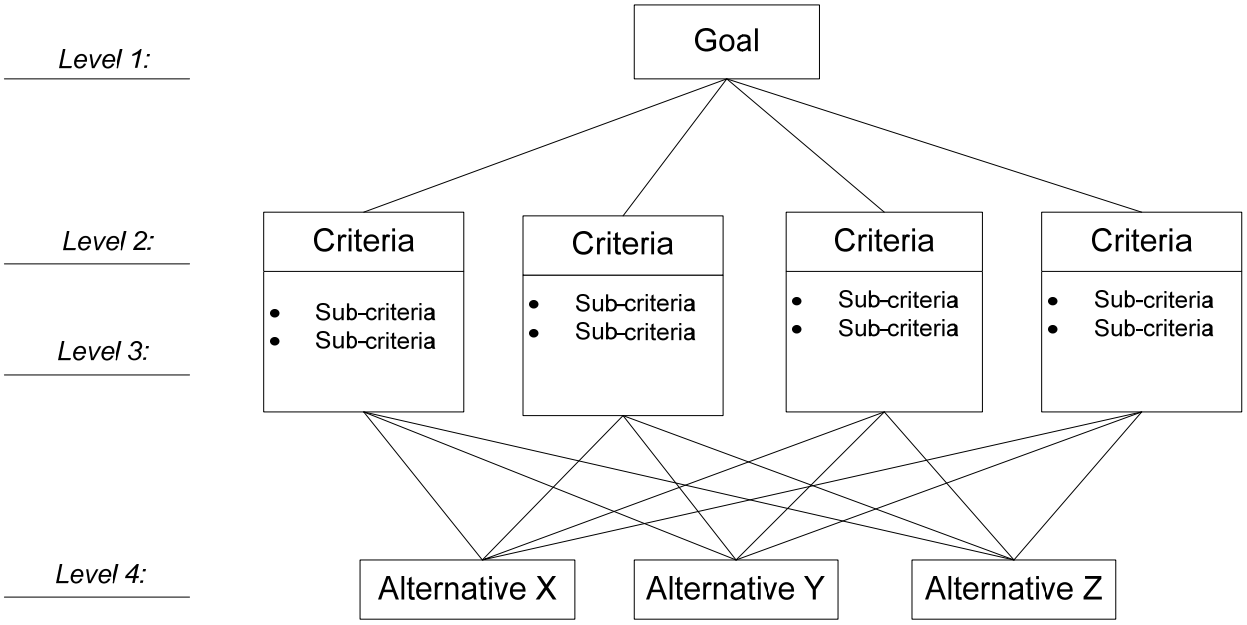

Figure 1: General structure of AHP. (Source: based on Chan, Chan and Lau, 2006)

Complex problems will entail several hierarchies, each with its mission, selection criteria, and alternatives.

2. Assign a relative importance of each selection criterion to the goal (mission).

This step is composed of two parts. First, weight ratio of each criterion needs to be determined. In order to do that, certain importance level is given to one criterion over the other. The scale is shown in the Table 2.

Table 2: The fundamental scale of absolute numbers. (Source: Saaty, 2008)

Intensity of importance	**Definition**	**Explanation**
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over the another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over the another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favor very strongly over another: its dominance demonstrated in practice.
8	Very very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.

Then, weight ratio can be defined by the formula (Saaty, 1994):

$$a_{ik} = \frac{w_i}{w_k} \tag{1}$$

where w_i – weight of criterion i, i = 1,2...n; w_k – weight of criterion k, k = 1,2...n; n – the number of criteria.

The criterion weights can be defined. This is done by constructing the pair wise comparison matrix. For a criterion compared with itself is always assigned the value 1 by convention, so all the main diagonal entries of the pair wise comparison matrix are 1. If there are n criteria, then the pair of wise comparisons will yield a square matrix as the matrix A (Dumitrache, 2010). It has been assumed that the n elements must make n(n-l)/2 elements of the pair-wise comparison. Let $C_1,C_2,...,C_n$ denote the set of elements, while a_{ik} represents a quantified judgment on a pair of elements C_i, C_k. The relative importance of two elements is rated using a scale with the values 1 to 9 as indicated in Table. An n-by-n matrix A as follows (Fan, Tsai, Lee, 2008):

$$A = [a_{ik}] = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{bmatrix} \end{array} \tag{2}$$

where $a_{ik}=1$ and $a_{ij}=1/a_{ik}$, i, k =1,2,...,n. In matrix A, the problem becomes one of assigning to the n elements $C_1,C_2,...,C_n$ a set of numerical weights W_1, W_2, ...,W_n that reflects the recorded judgments. If A is a consistency matrix, the relations between weights W_i and judgments a_n, are simply given by $W_i/W_k= a_{ik}$ and matrix A as follows (Tsai, Huang and Wang, 2008):

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \end{array} \tag{3}$$

The priorities can be obtained in *exact form* by raising the matrix to large powers and summing each row and dividing each by the total sum of all the rows, or *approximately* by adding each row of the matrix and dividing by their total (Saaty, 2008).

Then, consistency testing must be performed. The essential idea of the AHP is that a matrix A of rank n is only consistent if it has one positive eigenvalue λ_{max} while all the other eigenvalues are zero. Further, Saaty developed the consistency index (CI) to measure the deviation from a consistent matrix:

$$CI = (\lambda_{max} - n)/(n - 1) \quad (4)$$

Eigenvalue λ_{max} is calculated by formula:

$$\lambda_{max} = \sum_{k=1}^{n} a_{ik} \frac{w_k}{w_i} \quad (5)$$

From (Tsai, Huang and Wang, 2008)

The consistency ratio (CR) is introduced to aid the decision on revising the matrix or not. It is defined as the ratio of the CI to the so-called random index (RI) which is a CI of randomly generated matrices:

$$CR = CI/RI \quad (6)$$

where RI represents the average consistency index over numerous random entries of same reciprocal matrices. If CR $\leq$ 0.1, the estimate is accepted; otherwise, a new comparison matrix is solicited until CR $\leq$ 0.1. For n=3 the required consistency ratio (CR) should be less than 0.05, for n=4 it should be less than 0.08 and for n $\geq$ 5 it should be less than 0.10 to get a sufficient consistent matrix. Otherwise the matrix should be revised (Saaty, 1994).

RI values were determined by Saaty and are indicated below:

Table 3: RI values. (Source: Saaty, 1994)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

3. Rank alternatives under each criterion.

Constructing a matrix with a scale of relative importance in which it is compared the alternatives on each of the criteria. If there are m criteria, then the pair wise comparisons would yield a square matrix as the matrix B below:

$$B_i = [a_{kl}] = \begin{bmatrix} 1 & b_{12} & \cdots & b_{1n} \\ b_{21} & 1 & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & 1 \end{bmatrix} \quad (7)$$

where b_{kl} - the importance given to criterion i for the alternative k in comparison with alternative l with values between 1 and 9 or fractions like 1/x (with x between 1 and 9) to reverse the importance $b_{lk} = b_{lk}^{-1}$; k, l = 1..n; n - the number of alternatives (Dumitrache, 2010).

4. Rank each alternative's contribution to the mission.

This is the final step in AHP. Here, the priority weight of each criterion is synthesized with the priority score of each alternative in respect of that particular criterion in order to find out the overall priority weight of that criterion for the particular alternative.

Many excellent decision makers do not rely on a theory to make their decisions. Still academics differ about how people should and should not make decisions. Experiments with people have shown that what people do differs from the theoretical and normative considerations the experts consider important. This may lead one to believe that analytical decision making is of little value. But of many scientists indicate the opposite. Analytic decision making is of tremendous value, but it must be simple and accessible to the lay user, and must have scientific justification of the highest order. Here are a few ideas about the benefits of the descriptive analytical approach.

First, is the morphological way of thoroughly modeling the decision, inducing people to make explicit their tacit knowledge. This leads people to organize and harmonize their different feelings and understanding. An agreed upon structure provides ground for a complete multisided debate. Second, particularly in the framework of hierarchies and feedback systems, the process permits decision makers to use judgments and observations to surmise relations and strengths of relations in the flow of interacting forces moving from the general to the particular and to make predictions of most likely outcomes. Third, people are able to incorporate and trade off values and influences with greater accuracy of understanding than they can using language alone. Fourth, people are able to include judgments that result from intuition and emotion as well as those that

result from logic. Finally, a formal approach allows people to make gradual and more thorough revisions and to combine the conclusions of different people studying the same problem in different places (Saaty, 2009).

Grey Relational Analysis (GRA)

To describe shortly, Grey System Theory is mainly utilized to study system model uncertainty, analyze relations between systems, establish models, and forecast and make decisions. GRA is used to examine the extent of connections between two digits by applying the methodology of departing and scattering measurement to actual distance measurement (Noorul Kannan, 2006). Grey system theory is an interdisciplinary scientific area that was first introduced in early 1980s by Deng. Since then, the theory has become quite popular with its ability to deal with the systems that have partially unknown parameters. As a superiority to conventional statistical models, grey models require only a limited amount of data to estimate the behavior of unknown systems (Deng, 1989). Grey Relational Analysis (GRA) can be said to be one of most fundamental component of grey systems theory, because in it information from the grey system is used to quantify the effects of the various factors in order to determine their Grey Relational Grade (GRG). GRA provides an ideal means of analyzing the complex inter-relationships amongst the individual parameters in systems with multiple performance characteristics (Kuang Yu, 2009) and has been applied to a wide variety of optimization, decision-making (Yung Kung and Wen, 2007) and classification problems in such diverse fields as finance, business, economics (Yi-Chung, 2007), design, manufacturing and production.

Calculation of GRA is as the following (Lin, Chang and Cheng 2006):

1. Calculating the grey relational grade.

Let Xo be the referential series with k criteria of X1, X2, ...,X,..., Xn'(or N measurement criteria). Then:

$$
\begin{aligned}
&X_0 = \{x_0(1), x_0(2), \dots x_0(j), \dots x_0(k)\}, k = n \\
&X_1 = \{x_1(1), x_1(2), \dots x_1(j), \dots x_1(k)\}, \\
&\qquad\qquad \vdots \\
&X_1 = \{x_1(1), x_1(2), \dots x_1(j), \dots x_1(k)\}, \\
&\qquad\qquad \vdots
\end{aligned}
\tag{8}
$$

$X_N = \{x_N(1), x_N(2), \ldots x_N(j), \ldots x_N(k)\}$.

2.Data normalization.

The data series can be treated based on the following three kinds of situation and the linearity of data normalization to avoid distorting the normalized data (Hsia and Wu, 1997). They are:

(1) Upper-bound effectiveness measuring (i.e., larger-the-better)

$$x_I^*(j) = \frac{x_i(j) - \min x_i(j)}{\max x_i(j) - \min x_i(j)}, \tag{9}$$

where max x(j) is the maximum value of criteria j and min x(j) is the minimum value of criteria j.

(2) Lower-bound effectiveness measuring (i.e., smaller-the-better)

$$x_I^*(j) = \frac{\max x_i(j) - x_i(j)}{\max x_i(j) - \min x_i(j)}, \tag{10}$$

(3) Moderate effectiveness measuring (i.e., nominal-the-best)

If min $x_i(j) \leq x_{ob}(j) \leq \max x_i(j)$, then

$$x_i^*(j) = \frac{|x_i(j) - x_{ob}(j)|}{\max x_i(j) - \min x_i(j)}, \tag{11}$$

If max $x_i(j) \leq x_{ob}(j)$, then

$$x_i^*(j) = \frac{x_i(j) - \min x_i(j)}{x_{ob}(j) - \min x_i(j)}, \tag{12}$$

Or, if $x_{ob}(j) \leq \min x_i(j)$, then

$$x_i^*(j) = \frac{\max x_i(j) - x_i(j)}{\max x_i(j) - x_{ob}(j)}. \quad (13)$$

where $x_{ob}(j)$ is the objective value of criteria.

3. Calculate the grey relational coefficient $\Upsilon_{oi}(j)$.

The grey relational coefficient between the compared series X_1, and the referential series of X_0 at the j-th entity is defined as:

$$\Upsilon_{0i}(j) = \frac{\Delta min + \xi \Delta max}{\Delta_{0i}(j) + \xi \Delta max} \quad (14)$$

where Δmin = min min $\Delta_{0i}(j)$, Δmax=max max $\Delta_{0i}(j)$, and ξ is the distinguished coefficient ($\xi \epsilon [0,1]$.

4. Calculate the degree of the grey equation coefficient Γ_{oi}.

$$\Gamma = \gamma(x_i, x_j) = \sum_{k=1}^{n} \beta_k \gamma\left(x_i(k), x_j(k)\right) \quad (15)$$

where β_k represents the normalized weighting value of a factor. Or:

$$\Gamma_{oi} = \sum_{j=1}^{K} W_j \Upsilon_{oi}(j) \quad (16)$$

where w, is the weight of j-th criteria. If it is not necessary to apply the weight, take $w_1 = 1/K$ for averaging.

AHP and GRA model

In order to achieve the most accurate data and to utilize the possibilities offered by both above introduced models they will be combined into one AHP and GRA model. As the evaluation of supplementary funds will be performed in order to select the best fitting one. This means that both the qualitative criteria and quantitative criteria are considered simultaneously in the evaluation and selection of pension fund. The quantitative and qualitative criteria have the characteristic either of 'smaller-is-better' or 'larger-is-better'. Therefore, the proposed model deals with application

AHP method to obtain the criteria weights according to individual investors preferences and then, the application of GRA to integrate the qualitative and quantitative data, considering their characteristic larger-is-better or smaller-is-better and is done in terms of their overall system on multiple evaluation criteria.

The concept of combined AHP and GRA is a new one and has not been used for a very long time now, but none the less is thought of being a useful one. Like the base models of combined AHP and GRA its application field is as wide. Some examples of applications were for determining credit ability in banking sector (Lin and Chen, 2008), hospital performance evaluation (Wu, Chang and Lin, 2007), for training program selection (Chiang, Tsai and Lee, 2008), to rank insurance companies (Tsai, Huang and Wang, 2008) and for supplier selection.

The combined AHP and GRA model consists of elements from both models in order to optimize the evaluation process. Here is the general idea of how the model works and in which stage characteristics from which model are applied in order to implement the combined AHP and GRA evaluation model:

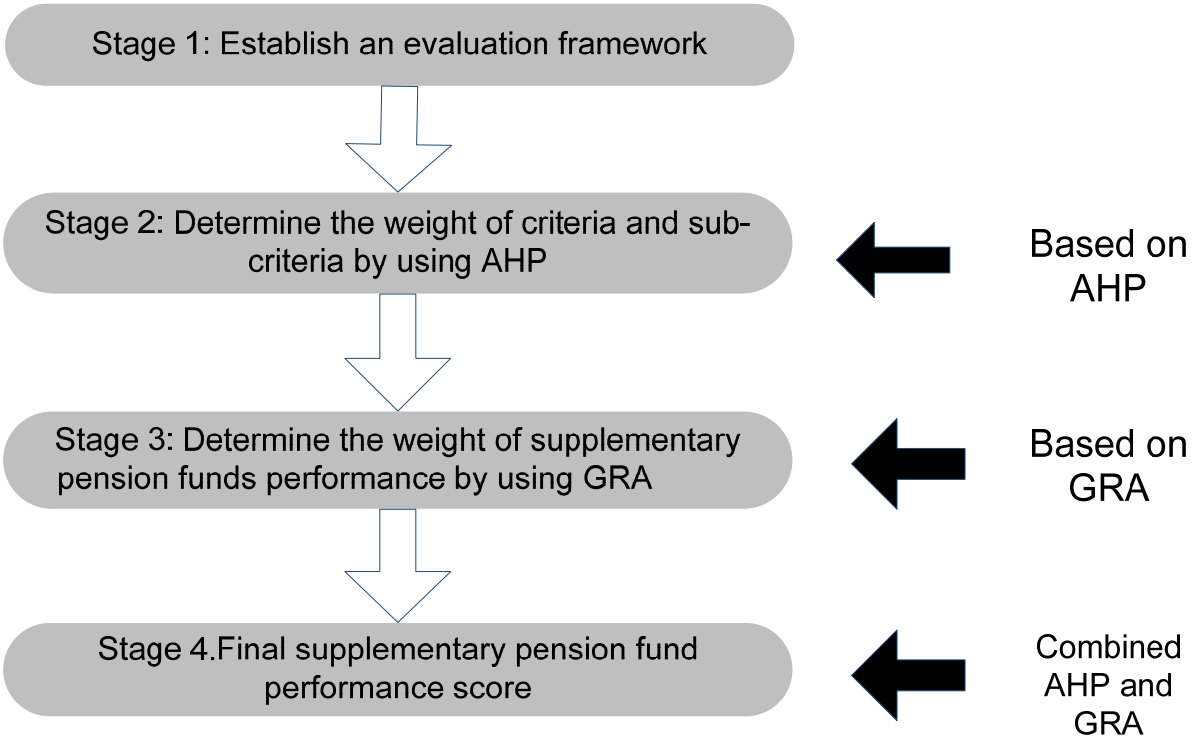

Figure 2: Combined AHP and GRA evaluation model (Adopted from Wu, Chang and Lin, 2007)

MODEL: As shown above, model consists of four stage and some stages consist of some steps. First stage is for choosing criterion, second uses AHP to weight the evaluative criteria, while

the third stage applies GRA to determine the weights of supplementary pension funds performance. And lastly, the fourth stage combines AHP and GRA to select the best supplementary pension fund for investor with predefined goals that are used in this paper. The model is detailed below.

First stage: Establishing the evaluation framework by choosing and defining qualitative and quantitative evaluation and selection criteria.

Second stage: applying AHP for determining relative criteria weightings.

This AHP model for determining the relative weights of evaluative criteria involves six steps as follows:

(1) Establish a hierarchical structure by breaking the pension fund selection problem into a hierarchy of interrelated decision elements, including the ultimate goal, criteria, and sub-criteria.

(2) Establish the pairwise comparison matrix using formula (1). The investor, with certain objectives makes a pairwise comparison of the decision elements and gives them relative scores.

(3) Calculate the eigenvector of each pairwise comparison matrix using approximation suggested by Saaty (2008).

(4) Test the consistency of each comparison matrix using formulas (4)-(5)-(6).

(5) Estimate the relative weights of the elements of each level.

Third stage: applying GRA to determine the weights of supplementary pension funds performance This GRA model involves five steps, as follows:

(6) Define the criteria and data treatment.

(7) Determine the referential series using formula (8).

(8) Normalize individual criteria values using formulas (9) and (10) to obtain $x_i^*(k)$, before calculating gray relational grades, in case of differences among individual criteria units.

(9) Calculate difference series $\Delta_{0i}(k)$,

(10) Calculate the relational coefficients, $\Upsilon_{0i}(k)$ of the compared series using formula (14).

Fourth stage: combining AHP and GRA to select the best supplementary pension fund for investor with predefined goals that are used in this paper

(11) Compute the relational grade, Γ_{oi}, by combining AHP and GRA and using formula (16).

(12) Select the top gray relational grades Γ_{oi}; which is the most suitable supplementary pension fund.

The main advantages of AHP can effectively manage tangible and intangible or qualitative and quantitative factors. One of the features of GRA is that both qualitative and quantitative relationships can be Identified among complex factors with insufficient information (relative to conventional statistical methods). Under such a condition, the results generated by conventional statistical techniques may not be acceptable without sufficient data to achieve desired confidence levels. In contrast, grey system theory can be used to identify major correlations among factors of a system with a relatively small amount of data (Wu, Lin, Chen, 2007).

Summing up the second chapter, it was identified that the main reasons for need of the model are: first, few investors have sufficient financial knowledge. Second, the available tools do not consider the preferences of individual investors; the tools implicitly assume that each screening variable is equally important to all investors. The described AHP and GRA models have answers to these problems. The main advantages of AHP can effectively manage tangible and intangible or qualitative and quantitative factors. One of the features of GRA is that both qualitative and quantitative relationships can be identified among complex factors with insufficient information.

The combined AHP and GRA model consists of elements from both models in order to optimize the evaluation process. It consists of four stage and some stages consist of some steps. First stage is for choosing criterion, second uses AHP to weight the evaluative criteria, third stage applies GRA to determine the weights of supplementary pension funds performance. And the fourth stage combines AHP and GRA to select the best supplementary pension fund for investor with predefined goals.

3. PENSION SYSTEM AND SUPPLEMENTARY PENSION FUNDS

This chapter is divided into three logical parts. First part is dedicated to describing pension system and pillars in Lithuania and place of supplementary pension funds in it. Second part is to review the supplementary pension funds market and its trends. The supplementary pension funds that will be later on evaluated using the model composed are represented. Each pension fund is shortly described in the way that shows what kind of investment style they are offering. Third part is to identify problems with the pension system and how investment into supplementary pension funds can help overcoming some of them.

3.1. Pension system in Lithuania

Pension system is one of the main element of social security and well being of the nation. Pension insurance is organized through it. Pension system is composed of all pensions (periodic payments to the insured till the end of his days), their delivery institutions and conditions. Society couldn't properly secure pension system without the help of the government, that's why cooperation is needed. It is influenced by some circumstances (Levišauskaitė and Rūškis, 2003):

1. Not all the people while working can save money for their retirement.
2. In the times of hyperinflation, the accumulated savings can decrease significantly.
3. A lot of people can't at all earn money and it means secure enough money for their retirement because of their disabilities or other similar factors. That is why government has to take care of them.

There are two types of *pension funds* in Lithuania. They are private and state. Private pension funds are controlled by private institutions (banks, insurance companies and ect.). State pension funds are controlled by the government of Lithuania (Levišauskaitė and Rūškis, 2003).

Pension funds provide people with income when they retire. They accumulate these funds with the help of employers and the deposits of workers themselves. Most part of these funds is invested into quality stocks, obligations, government securities, real estate. Activities of pension funds are strictly regulated by laws in order to minimize the risk of their activity. One of the risk limiting factors is the limitation of the structure of pension fund investment portfolio (Levišauskaitė and Rūškis, 2003). The basis of the existence of pension funds in general is solidarity between generations and between participants of a pension fund (Drijver, 2005).

With growth of economy and development of society, pension system must also evolve to suit new requirements. A multi-stage system is needed (Levišauskaitė and Rūškis, 2003). Every stage should be organized according different principles and that could safeguard 2 retirement security goals: the goal of saving and the goal of redistribution. One stage of pension system cannot implement both requirements.

Lithuania built its social insurance schemes in the first years of its independence between 1918 and 1940. In line with the other Baltic countries, after the II World War, pension institutions were highly influenced by the communist ideology. The Lithuanian system was thus replaced by the soviet institutional architecture (within the USSR). Administrative responsibilities within it were shared between different institutions: state social security administration, trade unions, and the Soviet Union budget (Poškutė, 2003).

As noticed by Lazutka R. (2007), the effort to create a new public pension scheme in Lithuania was an integral part of the restoration of the independent state and reformation of the economic and political system in 1990. During the eighties, the Lithuanian governments developed the Bismarckian type of pension scheme. The present pension system was introduced through the Law on the Pension Scheme Reform of December 2002. This was after a period of legislative innovations started at the beginning of the 1990s. However, finally the neo-liberal ideology was accepted by the main political parties and partial privatization of social insurance pensions has started since 2004.

The pension reform in Lithuania was initiated with the aim to:

- Provide conditions for the insured to receive higher pensions
- Reduce the effects of the aging population on the pension system
- Gradually reduce the tariff for pension insurance and this way decrease the labour costs
- Strengthen the capital market, thus stimulating growth for the Lithuanian economy

In general, the essence of the pension reform was the transition from the current pension system – where the collected funds were only redistributed to a system that is based on accumulation. Starting from 1 January 2004, every person subject to mandatory state social insurance may accumulate a portion of his/her pension in a personal account held with the pension fund the person chooses. According to that the second and third pillars were introduced.

The first (state and mandatory) pillar, consists of the Social Insurance Pensions financed by the State Social Insurance Fund Budget and thus from social contributions. It is of a PAYG (pay as you go) type. In case of deficit, the state budget guarantees the solvency of the State Social

Insurance Fund. The social insurance benefit consists of two parts: the flat-rate basic part for the insured who have paid contributions for the mandatory insurance period; and the supplementary part only for those persons who have made contributions while working under a labor contract. The retirement age is 62 years and 6 months for men and 60 years for women. 24% of an employee's gross earnings is transferred by the employer to SoDra (22% for pension insurance and 2% for other social allowances). (Natali, 2004; SoDra).

The second pillar is represented by supplementary funded pensions introduced in December 2002. Insured persons have the possibility to accumulate part of their state social insurance contributions (2% of income) in pension funds or insurance companies' accounts. This corresponds to the opportunity of shifting part of contributions collected by the state into private funds (opt-out).

As noted by Gudaitis T. (2009), transferring part of social insurance payments to pension funds will decrease the 1st pillar pension, but it should insure the larger accumulated pension in the 2nd pillar funds.

When you have decided to participate in 2nd pillar pension fund it is impossible to withdraw from it, unless you do that not later than 3 years from the signing of the contract with the pension fund company (Lietuvos Respublikos Vertybinių Popierių Komisija, 2005).

***Third pillar* (or *supplementary pension fund*)** is a voluntary saving towards the retirement pension in pension funds managed by pension accumulation companies. To save money or invest on your own is hard and not always possible to avoid money depreciation. That is why people participate in 3rd pillar pension schemes. Everyone can take part in supplementary pension funds even if they are not participating in 1st and 2nd pillar pension funds (Lietuvos Respublikos Vertybinių Popierių Komisija, 2005).

Supplementary pension funds are assets held by natural persons, who participate in pension accumulation in accordance with the Law of the Republic of Lithuania on Pension System Reform, as the right of joint partial ownership. The management of the pension fund is transferred to a pension accumulation company, and is invested in accordance with the regulations of the pension fund concerned.

In the Republic of Lithuania Supplementary Pension Fund law activity of pension funds is defined as financial-economical activity which seeks to accumulate supplementary funds of people for their retirement and do that by setting pension agreements to collecting money, investing and reinvesting this money into diversified investment portfolio, and pay pension payoffs according

conditions stated in the laws and pension schemes. In Lithuania pension payoffs for the participants in the pension scheme can be paid in 3 ways: 1) one-off pay; 2) regular payoffs; 3) by purchasing an annuity in insurance company that manages the pension fund.

As it has been introduced earlier in this paper - pension funds collect, pool and invest funds contributed by beneficiaries and sponsors to provide for the future pensions of beneficiaries. As OECD Secretariat (2005) has defined: they are a means for individuals to accumulate savings over their working lives to finance their needs in retirement. That means, consequently, the ultimate risk for pension funds is that asset returns will not be sufficient to meet promised benefits and required household needs.

Actually, pension funds pose a different set of risks than other financial institutions, such as banks. Pensions are long-term contracts and they involve a sizeable proportion of the individual's wealth. However, the existence of assets in pension funds avoids the danger of the type of runs that can occur in banking crises (Whitehouse, 2000).

According to OECD Secretariat (2005) the most basic decision to be made by a pension fund is regarding how to allocate funds amongst various asset categories and available financial instruments to assure sufficient investment returns over time and that unnecessary volatility does not reduce asset values when liquidity needs arise.

3.2. Supplementary pension funds market

In the Table 4 the listing of these funds is given with establishment dates and the name of their management company.

Table 4. Supplementary pension funds. (Source: Made by author using data from VPK and Swedbank)

No.	Pension fund	Approval of pension fund in the securities paper commision	Management company of pension fund
1	Finasta akcijų pensija plius	2004-12-17	UAB „Finasta investicijų valdymas“
2	Finasta obligacijų pensija plius	2004-12-17	UAB „Finasta investicijų valdymas“
3	DnB NORD papildoma pensija	2004-10-21	UAB „DnB NORD investicijų valdymas“
4	DnB NORD papildoma pensija 100	2007-09-06	UAB „DnB NORD investicijų valdymas“
5	Citadele papildomas savanoriško pensijų kaupimo fondas	2004-10-21	UAB „Citadele investicijų valdymas“
6	SEB pensija 1 plius	2004-10-21	UAB „SEB VB investicijų valdymas“
7	SEB pensija 2 plius	2004-10-21	UAB „SEB VB investicijų valdymas“
8	MP MEDIO III	2007-09-20	UAB „MP Pension Funds Baltic"
9	MP EXTREMO III	2007-09-20	UAB „MP Pension Funds Baltic"
10	Swedbank Pensija 1 Plius	2005-01-01	Swedbank Life Insurance SE
11	Swedbank Pensija 2 Plius	2005-01-01	Swedbank Life Insurance SE
12	Swedbank Pensija 3 Plius	2005-10-10	Swedbank Life Insurance SE

SEB Investicijų valdymas

According to data from SEB investicijų valdymas internet website, a subsidiary company of SEB Bank today offers two supplementary pension funds:

1. *Fund SEB pensija 1 plius* will invest seeking to increase value of accumulated assets and to retain a low risk. The largest portion of the fund assets (70-100 %) will be invested into debt securities and money market instruments. The remaining portion will be invested in equities in developed economies, Lithuania and other Baltic countries.
2. *Fund SEB pensija 2 plius* will invest seeking to increase value of assets accumulated by the fund participants in the long-term and retain a medium risk. The largest portion

of the fund assets (60-100 %) will be invested in equities in developed economies, Lithuania and other Baltic countries. The remaining portion will be invested in debt securities and money market instruments.

Citadele Investicijų valdymas

According to data from Citadele internet website Citadele supplementary pension fund offers a balanced investment strategy. In order to ensure long-term growth of the fund's assets and protect the capital of its participants, the Management Company should invest into Governments' fixed income securities (bonds) not less than 25% of the assets of the fund. The Management Company can invest into equity securities up to 50% of the fund's asset, up to 75% - into fixed income securities and up to 50% - into deposits held with Lithuanian and foreign financial institutions.

FINASTA Investicijų valdymas

According the data from Finasta internet website Finasta Investicijų valdymas offers two types of pension funds at the moment:

1. *Finasta obligacijų pensija plius*. The assets of "Finasta bond pension plus" fund are invested in debt securities and/or investment units (shares) of investment funds that invest mainly in debt securities.
2. *Finasta akcijų pensija plius*. The voluntary pension fund assets of "Finasta equity pension plus" are invested in equity securities (shares) and/or investment units (shares) of investment funds that invest mainly in equity securities. The fund searches for and invests in potentially undervalued companies with a strong growth potential. In extraordinary circumstances the pension fund may be temporarily invested in debt securities, money market instruments and/or investment units (shares) of investment funds that invest mainly in debt securities and/or money market instruments.

DnB NORD Investicijų valdymas

According to the data from DnB Nord Investicijų valdymas internet website it has 2 supplementary pension funds: papildoma Pensija and papildoma Pensija 100.

1. *Papildoma Pensija* – its a supplementary pension fund that uses golden middle investment strategy when considering risk and profitability. Not more than 50 % of assets can be invested into equity markets, the other part can be invested into government, companies or banks bonds and deposits.

2. *Papildoma Pensija 100* – it's a supplementary pension fund which all of the assets can be invested into international equity markets. To achieve profitability in the long run, but with more risk.

Pension Funds Baltic

According to the data from Pension Funds Baltic internet website it has two supplementary pension funds available:

1. *MP EXTREMO III* – this is the fund where 100 % of funds assets can be invested into equity markets. The swinging in price of stocks can be not profitable in the short run but in the long run they can be very profitable.
2. *MP MEDIO III* – this is the fund where not more than 70 % of fund assets can be invested into equity markets and the rest is invested into bonds and terminated deposits. In the short run the value does not change much and that is indicated by lower profits but also less risk.

Swedbank Life Insurance SE

According to the data at Swedbank internet website it has three supplementary pension funds:

1. *Swedbank pensija 1 plius* – it's a medium risk investing strategy. Most part of the fund assets (about 70 %) is invested into government bonds and the other 30 % of funds are invested into equity markets.
2. *Swedbank pensija 2 plius* – has a greater potential for profits in the long run. About 60% of fund assets are invested into equity markets, and the left part is invested into bonds.
3. *Swedbank pensija 3 plius* – seeks maximum profitability for the ones who ere not afraid of risks. Fund assets are fully invested into equity markets.

According to The Securities Commission of the Republic of Lithuania (2010) as of 31 December 2010, there were 9 voluntary supplementary pension accumulation funds managed by 5 management companies. Two supplementary funds were managed by UAB „SEB investicijų valdymas", two by „Finasta Asset Management", two by UAB „DnB NORD investicijų valdymas" and two by UAB „MP Pension Funds Baltic". UAB „Citadele investicijų valdymas" – managed one fund.

Three supplementary pension funds were managed by Swedbank Life Insurance SE. VPK lists Swedbank as an issuer whose value papers are not included in trade in VPK regulated markets. Further, supplementary pension funds offered by Swedbank and managed by Swedbank Life Insurance SE are not separately formed pension funds with their own portfolios, but this is an opportunity to invest into already existing funds (these are: Swedbank funds of funds 30, 60 and 90) just with the conditions of participation that would be same as in another institution offering supplementary pension funds. For these reasons certain information about supplementary pension funds market is not completed with Swedbank pension funds (for example number of participants or size of assets) as this information is not available. This means that review of market will mostly be made on the basis of the 9 pension funds management companies that are regulated by VPK.

Number of participants in supplementary pension funds

Before starting it has to be noted that because information from Swedbank Life Insurance SE was not available on certain topics, pension funds managed by this company will not be included in review of number of participants in supplementary pension funds, asset size and asset allocation.

Table 5. Division of assets and participants in supplementary pension funds by fund management company. (Source: VPK)

Name of the management company	**Pension Fund**	**Assets, mln LTL**	**Assets (%) according management companies**	**Number of participants in 3rd pillar PF**	**Participants (%) according to management companies**
UAB „SEB investicijų valdymas“	SEB Pensija 1 plius	13,71	67,4%	1.725	51,57%
	SEB Pensija 2 plius	44,99		9.955	
UAB „DnB Nord investicijų valdymas“	„DnB Nord papildoma pensija“	16,91	20,9%	7.194	33,65%
	„DnB Nord papildoma pensija 100“	1,31		427	
UAB „Finasta investicijų valdymas“	„Finasta akcijų pensija plius“	5,60	8,8%	1.641	10,33%
	„Finasta obligacijų pensija plius“	2,02		698	
UAB „Pension Funds Baltic“	„MP MEDIO III“	0,54	2,7%	199	4,17%
	„MP EXTREMO III“	1,76		745	
UAB „Citadele investicijų valdymas“	„Citadele papildomas savanoriško pensijų kaupimo fondas“	0,18	0,2%	66	0,29%
	Total:	87,035	100%	22.650	100%

On 2010 September 30th the assets of supplementary pension funds amounted to more than 87 mln. LTL and the number of participants was more than 22,65 thousand. In that period the biggest amount of participants (51,6%) and the amount of assets (67,4%) belonged to management company UAB „SEB investicijų valdymas“. In UAB „DnB Nord investicijų valdymas“ the respective numbers were 33,7 % and 20,9 %. In these supplementary pension funds management companies 85,2 % of total participants were saving for their pensions.

The biggest supplementary pension fund was „SEB Pensija 2 plius“. Its assets were more than 45 mln. LTL and the number of participants was 9,9 thousand people. The second supplementary pension fund was „DnB NORD papildoma pensija“. Its number of participants

composed a little less than one third of the market and assets composed about one fifth of all supplementary pension funds market assets.

Because of the positive investment returns and the investment of new participants, the assets of the supplementary pension funds grew 4,83% or more than 4 mln. LTL (from 83 mln. LTL) in the third quarter of 2010. The positive results of the supplementary pension funds attract new investors. It is already the fourth quarter that the number of participants in supplementary pension funds is growing. The number of participants in the third quarter grew by 0,9% or by 197 investor. This is the greatest amount of participants that supplementary pension funds had since the beginning.

This data strongly suggests that supplementary pension funds belonging to banks and insurance companies gained many members by using their established reputation, as well as their powerful branches and networks (Iwasaki and Sato, 2006).

Assets allocation of supplementary pension funds

In the ending of September of 2010 asset allocation according to asset classes has not changed much: 63% of assets of supplementary PF's were invested indirectly, that is via collective investment objects (investment funds, investment companies). The value of these assets was about 54,6 mln. LTL. Almost 78% of indirect investment was composed of subjects investing into shares. The amount of shares and investment objects investing into shares in the portfolio was 54,2 %. But on the other hand, the amount of total portfolio invested into direct shares was only 5% (4,7 mln. LTL). Value of government value papers (VVP) value was more than one fifth (21,6%) of all assets portfolio.

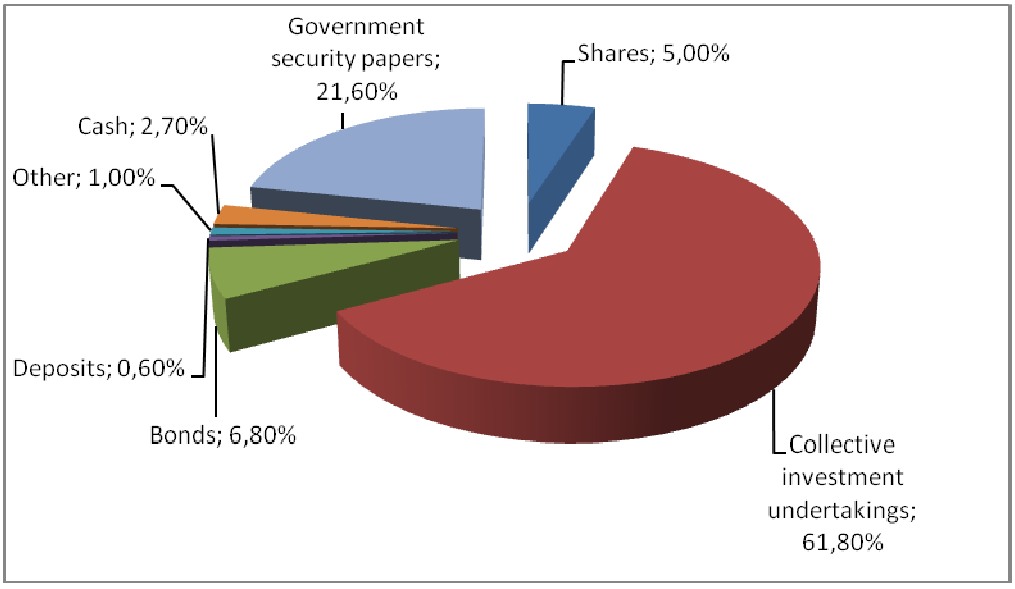

Figure 3: Division of investment according asset classes. (Source: VPK)

The biggest investment from VVP side was that the most (48,3% or 9,1 mln. LTL) was invested into Lithuanian VVP. 15% (2,8 mln. LTL) was invested into German VVP and 9% (1,7 mln. LTL) was invested into each of France and Austria's VVP. The biggest part of investment into direct investment to companies obligations (29%) was to Lithuanian issuers (1,7 mln. LTL).

Almost 60% (32,5 mln. LTL) of all investment into collective investment undertakings was made to Luxemburg registered undertakings. 8 mln. LTL (14,7%) was invested into undertakings registered in Ireland.

As can be seen from the Figure 4, 17,1% of all supplementary pension funds assets was made in Lithuania (these are investment into Lithuanian VVP, Lithuanian companies shares, obligations, collective investment undertakings, deposits, cash). The total value of these investments is almost 14,9 mln. LTL. The other part - almost 83% (72,2 mln. LTL) was invested in to value papers registered in foreign countries.

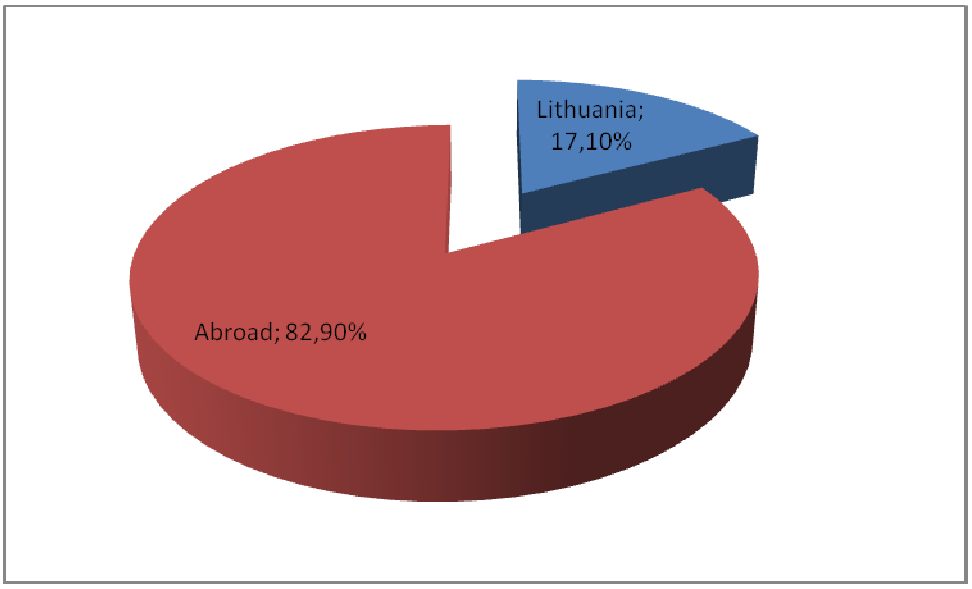

Figure 4: Investment allocation according investment in Lithuania and abroad. (Source: VPK)

After investigating direct investment (excluding investment into collective investment undertakings) according regions (total of 32,4 mln. LTL). In the discussed quarter, managers of PF's invested mostly into Baltic region markets (39% or 12,6 mln. LTL). At the same time, investment into West Europe markets, comparing to the second quarter of 2010 decreased by 40,7% to almost 38% and was 12,3 mln. LTL. Into other regions, that is middle and eastern EUrome, it was invested 11,2% of total investments.

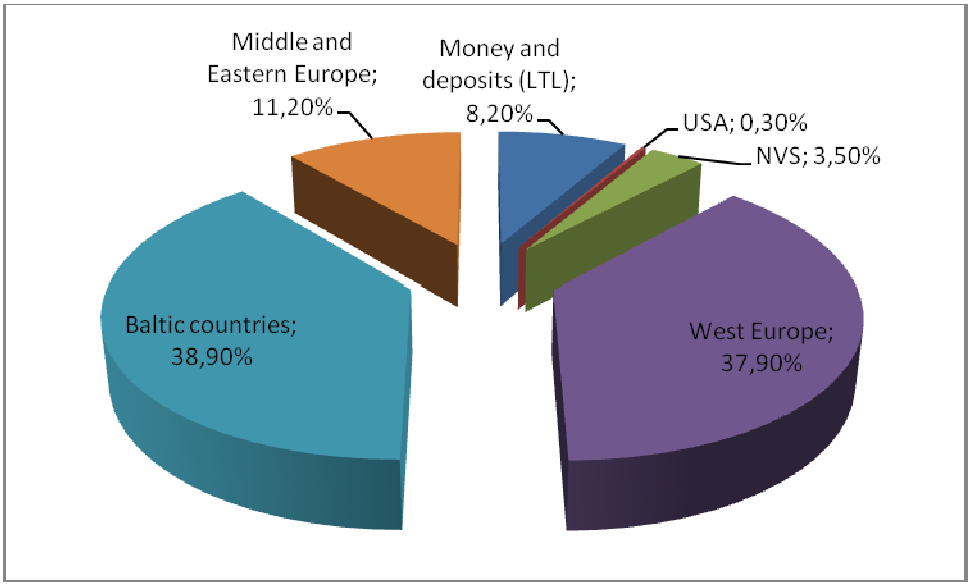

Figure 5: Direct investment (excluding investment into collective investment undertakings) division according regions. (Source: VPK)

Results of investing activities of supplementary pension funds

After the unsuccessful 2nd quarter, the positive tendencies of 3rd quarter in financial markets have affected the performance of supplementary pension funds as well. The unit value has by average increased by 3,33% and the total result of supplementary PF's from the beginning of 2010 has increased by about 7,26%.

Since „SEB Pensija 2 plius" was the biggest supplementary PF according assets (also the number of participants) its results had the biggest impact in calculating the performance of the whole supplementary pension funds market in Lithuania. All unit values of all pension funds were positive in the third quarter. And the biggest increase was by 7,07 % of „Finasta akcijų pensija plius" . From the beginning of 2010 the greatest increase per unit value was that of „Finasta akcijų pensija plius" (+13,87%) and „Finasta Obligacijų pensija plius" (9,15%).

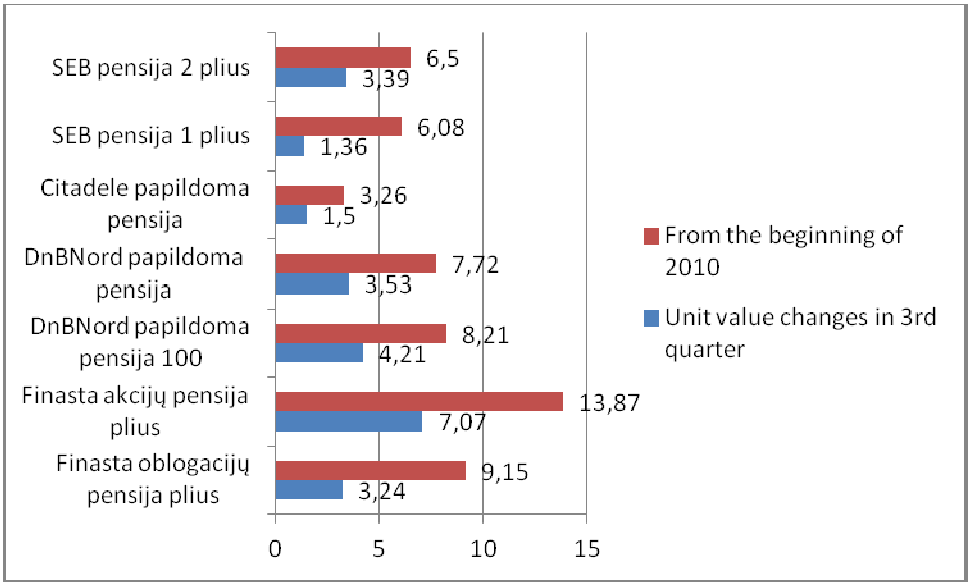

Figure 6: Supplementary pension funds change of unit value (%) during third quarter of 2010 and since the beginning of 2010. (Source: VPK)

3.3. Growing importance of supplementary pension funds

Making a choice and invest in other means for retirement (other than 1st and 2nd pension pillar) has become a soaring issue. Making a correct choice, suitable choice for you, is now more important than ever. There are some main reasons for that, but the general problem is that 1st and 2nd pillar system in Lithuania is somewhat collapsing and there is a very high and real probability that when time comes – the funds that are available for ones retirement are just not sufficient to live on.

Here is a more detail look at the problem of the failing pension system:

Ageing of the population is a global trend. People globally live longer as a result of the improved living conditions and the medical progress. This means that there are fewer young people able to work, and more old people. In the context of the pension system, this causes increase of the number of old people which receive pension and longer period of taking pension, which results in a growth of costs for pensions and bigger burden for the pension system. On the other hand, the revenue side is weakened since there are less people able to work and pay contributions to the pension system. Pension saving must be followed in the context of the living cycle, i.e. entry of the persons in the labour market until their death. While active, people work and earn and set aside part of their earnings as savings for pension. The question is whether the persons that worked for around thirty years (for example, from the age of 30 to 60) will save sufficiently for pension that would be used around twenty years (the expected duration of life after retirement, i.e. from 60 to 80)?

World bank (2008) has made a very concrete conclusion about this problem: despite the pain countries have endured during the global financial and economic crisis, the impact of this crisis pales in comparison to what the countries are soon to face as the region continues to age. It is sobering to look at the impact of the most severe version of the global financial crisis next to the impact of the demographic crisis to come. Future pension system deficits are expected to be threefold what is currently being experienced in the worst hit countries and are expected to remain at that level for more than 20 years before slightly improving.

The impact of the financial crisis on individuals participating in funded defined-contribution schemes depends on four main factors: (i) changes in asset prices and the potential recovery over the medium term; (ii) the proportion of pension wealth that is supported by funded individual account assets; (iii) the presence of minimum social pensions or guarantees that are integrated into the pension system; and (iv) the requirement and framework for mandatory annuitization of the accumulated balance at retirement (World Bank, 2008).

Losses in asset values over the year 2008, right when the global financial crisis hit, reported by pension funds have been considerable. In countries that had funded systems these losses ranged between 8% and 50%. While the losses may be disturbing over the short term, they should not be taken as an indicator of the overall longer term performance of the funds which is the relevant perspective for any pension system.

Ways of government coping with deficit budget. Sure, earnings related with pay-as-you-go pension systems were affected in a less dramatic and immediate way as the economic downturn reduces their stream of revenue and potentially increases benefit claims. But still, global recession reduced contribution revenue in most countries as a result of decrease in employment or reductions in the level of earnings on which contributions are levied. In addition, pension expenditures from such schemes increased as more individuals retire from the labor force and seek pension benefits in the face of an economic downturn (World Bank, 2008). Policymakers need to be cautious that their response to this crisis does not exacerbate the next one. In past crises, governments have responded to rising unemployment by loosening early retirement and disability restrictions. Increased retirement now will shift the baseline deficits even higher as potential revenues decline and expenditures rise. Transferring second pillar contributions to the first pillar also involves an increase in future liabilities for the first pillar.

The last is what Lithuanian government did. To cope with opening gap in the budget Lithuanian government decided to level the amount of salary that can be transferred to the 2nd pillar pension funds. It was decreased from 5,5% to 2 %. This is the lowest tariff in the world between the

countries that started their pension reform. This can be seen in the Table below. This can be interpreted that people are being forced to come back to the old system. But no matter the interpretation this lowering of the tariff means that when, in this time of recession, 2nd pillar fund holdings could have much increased by buying cheep assets, that in the long rung will eventually raise, could have made a big profit for the participants. If one wants to have more control over his future alternative investments for retirement are the only way.

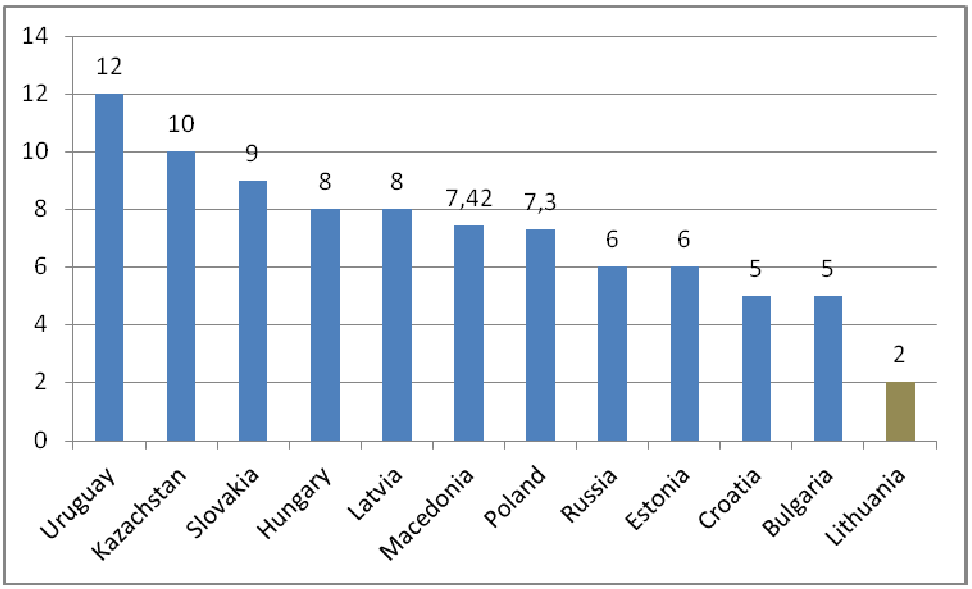

Figure 7: Size of investment to second pillar pension funds. (Source: World bank)

Concluding remarks. Many countries face a crisis in their pension systems. According Apostolska and Petroska (2007) pension systems have functioned successfully while they were young, while they had major inflow of funds in the system from the contributions, and small outlays for paid pensions. The maturity of the pension systems, as a result of the ageing of the population, results in expressed problems with payment of the promised pensions. In addition, the problems with these systems are the historically "generous" pensions unlike the inappropriately low contribution rates during the existence of the systems and the changes in the economic conditions, i.e. reduced employment rates and reduced payment of contribution.

As it is noticed in Banque nationale de Belgique (2007) it is evident that participants of supplementary pension funds have a lower average income than the long-standing participants. These developments point to a tendency towards democratization of the supplementary pension funds. True, various categories less able to rely on the first two pension pillars are quite justifiably more inclined to participate. This applies particularly to the self-employed and persons taking early retirement. The crisis also unmasked some particular vulnerabilities of the second pillar pension systems in the region: (i) vulnerability of benefits during accumulation and decumulation stages to

vagaries of financial markets, (ii) regulatory limits which discourage risk-taking and result in lower returns to participants, and (iii) the need for stronger capital market development. (World Bank, 2009). As a result, the third pillar can nonetheless help to limit the loss of purchasing power after retirement and remedy some of the shortcomings of the statutory system.

Pension funds in Lithuania are formed by the fund manager. Every person has a possibility to choose the manager and the pension fund managed by this manager. Choosing the pension fund, individual chooses the policy of investment, as different pension funds propose different possibilities of investment – from conservative (investment possible only in debt securities issued or guaranteed by the governments of the Republic of Lithuania, the European Union or the Organization of Economic Cooperation and Development, central banks and the European Central Bank or in investment funds) to rational risk. As the participation in the third pillar is entirely voluntary, individuals may choose fund, manager, possibility to reverse decision of accumulation and terminate agreement (under conditions provided in the rules of the specific fund) (The Peer Review in Social Protection and Social Inclusion and Assessment in Social, 2008).

Summing up the first chapter, management companies seeks to accumulate supplementary funds of people for their retirement and do that by setting pension agreements to collecting money, investing and reinvesting this money into diversified investment portfolio. Supplementary pension fund is one of the instruments that can remedy some of the shortcomings of the statutory system. The pension fund management companies offer pension funds of three different investing strategies (not every management company offers all thereof them): safe investment, medium risk, and risky investing strategy.

4. APPLICATION OF EVALUATION MODEL TO LITHUANIAN SUPPLEMENTARY PENSION FUNDS

In the fourth chapter I will show the practical result of the theoretical bases discussed in the previous chapters. That is, by the use of combined AHP and GRA evaluation and selection framework, the most suitable supplementary pension fund for the certain relative individual investor shall be calculated. The choice and evaluation is based on the particular investors preferences over availability, fund performance and fund descriptive criteria. The correlated relation then shall be calculated to obtain the relational grade and get the final score.

4.1. AHP and GRA model application process

Before beginning the application of the AHP and GRA model the note must be said, on which the further structure of the chapter and the manner of evaluation shall depend. As it has been already mentioned in the third chapter - VPK lists Swedbank as an issuer whose value papers are not included in trade in VPK regulated markets. Further, supplementary pension funds offered by Swedbank and managed by Swedbank Life Insurance SE are not separately formed pension funds with their own portfolios, but rather an opportunity to invest into already existing funds (these are: Swedbank funds of funds 30, 60 and 90) just with the conditions of participation that would be same as in another institution offering supplementary pension funds. For these reasons certain information of Swedbank pension funds is not available. Being more precise the information on size of Swedbank supplementary pension funds is not available.

This means that there will be two evaluations. With all chosen criteria, but excluding Swedbank's supplementary pension funds; and without one criterion (size of pension fund) but including supplementary pension funds offered by Swedbank.

Since all the necessary notes have been made we can proceed with the model application. This shall be done by following the stages indicated in the end of chapter two.

<u>Stage 1:</u> establishing the evaluation framework by choosing and defining qualitative and quantitative evaluation and selection criteria.

In order to choose the criteria for the evaluation model the list of criteria, used to evaluate banks and mutual funds were found and combined into a Table 6 below.

Table 6. Evaluation criteria for banks and mutual funds. (Source: made by author using data from Michael and Lesseig (2005); Gözbaşı and Çıtak (2010); Thwaites and Vere (1995))

Bank	Mutual fund
1. Free banking 2. Size of ATM network 3. Overdraft size and availability 4. Fast and efficient service 5. Interest chained on borrowing 6. Range of services offered 7. Reputation 8. Availability of information 9. Availability of credit 10. Friendliness 11. Service charges on checking accounts 12. Interest charges on loans 13. Location 14. Parking 15. Hours of operation 16. Interest payments on savings accounts 17. Special services for youths 18. New account premiums or gifts	1. Performance of the fund (various ratios) 2. Fund risk 3. Expense ratio 4. Number of funds in fund family 5. Fund management fees (excluding commissions) 6. Fund size 7. Tax efficiency 8. Fund manager tenure 9. Funds manager experience 10. Fund manager reputation 11. Fund founder 12. Fund age 13. Number of fund holdings 14. Fund objective 15. Fund load 16. Fund 12b-lfees

In the Table 6 there are evaluation criteria recognized by authors. In order to ease the evaluation and selection of mutual fund Michael A. Jones, Vance P. Lesseig, et al. (2005) in their article identified 14 main mutual fund valuation criteria and 7 were identified by Onur Gözbaşı and Levent Çıtak. (2010) (since some of them repeat themselves the combined number is 16). The same but for banks was done by Des Thwaites and Lizanne Vere (1995). They distinguished 18 criteria

It is a fact that banks and mutual funds differ in the way they work and what services they offer as well as they both have differences and similarities with pension funds. Hence, to accumulate the list of criteria to evaluate the supplementary pension funds, from both of the suggested lists, banks and mutual funds, ones suitable for pension funds were taken. And these are the criteria: location, fund performance (these are Sharpe, Treynor, Information and Sortino ratios, also average yearly returns), age of fund, size of fund, fund management fees, availability of information.

As it has been mention before, pension funds in some ways differ from banks and mutual funds, so there is a need to introduce some additional criteria that are unique and suitable to supplementary pension funds. The additional criteria are these: minimal installment, up-load sum, conditions for switching funds.

To sum up, for the evaluation model 13 criteria have been chosen and divided into three subcategories:

Accessibility

1. Location
2. Information availability

Performance

3. Sharpe ratio
4. Treynor ratio
5. Sortino ratio
6. Information ratio
7. Average yearly return (%)

Fund descriptive parameters

8. Fund size (LTL)
9. Management fees (%)
10. Minimal installment (LTL)
11. Up-load sum (LTL)
12. Conditions for switching funds (%)
13. Funds age (years)

Hence, the ultimate goal of evaluating the ideal supplementary pension fund can be achieved by evaluating three main indicators of pension funds. These are: the accessibility of supplementary pension fund, performance of pension fund and the fund descriptive parameters.

I. Fund accessibility

(1) Location. Firstly, the criterion of location was chosen because not all the people live in big cities that are filled with management companies' subsidiaries which means that they may choose the pension fund that has its subsidiary in their hometown rather than the one that does not (which would make them take a trip to another town). What is more, some pension

fund management companies have only two or three subsidiaries in two biggest towns – this means possible loss of a very big amount of investors who may prefer comfortability to other things.

Here is the data for supplementary pension funds management companies according this criterion, listed in the Table 7 below:

Table 7: Number of branch offices of supplementary pension funds management companies. (Source: made by author)

	Cities	Branch offices
UAB „SEB investicijų valdymas“	27	57
	27	57
UAB DnB NORD investicijų valdymas	49	85
	49	85
UAB „Citadele investicijų valdymas“	6	15
UAB „Finasta investicijų valdymas"	3	3
	3	3
UAB „MP Pension Funds Baltic"	3	3
	3	3
Swedbank Life Insurance SE	54	98
	54	98
	54	98

(2) Information availability. This was chosen as one of the criterions for a simple reason– simplicity is what investors like. The information that they need (information that a pension fund is required to give, show or report) has to be found easily and in understandable form. One pension funds have adopted the system that makes it easy to find the information – the others do not.

Here is the data for supplementary pension funds management companies according this criterion, listed in the Table below. Score scale was from 1 – hard to find to 4 – simple and easy to find.

Table 8: Availability of information from supplementary pension funds management companies. (Source: made by author)

	Easy to find info	Internet banking	Reports	about fees	description	**Total**
UAB „SEB investicijų valdymas“	3	4	4	3	2	**16**
	3	4	4	3	2	**16**
UAB DnB NORD investicijų valdymas	3	4	4	4	2	**17**
	3	4	4	4	2	**17**
UAB „Citadele investicijų valdymas“	1	3	4	2	2	**12**
UAB „Finasta investicijų valdymas"	3	3	4	4	3	**17**
	3	3	4	4	3	**17**
UAB „MP Pension Funds Baltic"	3	3	4	3	3	**16**
	3	3	4	3	3	**16**
Swedbank Life Insurance SE	3	4	4	2	3	**16**
	3	4	4	2	3	**16**
	3	4	4	2	3	**16**

II. Performance of pension funds

Before continuing with chosen criteria the notion has to be made. In order to calculate the chosen ratios, benchmarks of supplementary pension funds had to be defined. Supplementary pension funds managed by UAB „DnB NORD investicijų valdymas" and UAB „Finasta investicijų valdymas" are the only ones that had already defined their benchmark composition. In order to be able to carry out the evaluation, benchmark indices had to be identified for the rest of the supplementary pension funds. They were compose by authors judgment, following the rules stated by VPK (Lietuvos Respublikos vertybinių popierių komisjija).

VPK states that: management company has to choose the index that will be treated as the benchmark index for certain supplementary pension fund. The rules to do that are: benchmark index has to be chosen is such a manner that it would reflect the rules and investing strategy of the pension fund – asset classes, their proportions, and geographical allocation of investment.

As can be seen from the Table below, benchmarks were composed by looking at what indices were used by other pension fund management companies and considering the asset classes and geographical regions of investment.

Table 9: Benchmark composition of supplementary pension funds. (Source: VPK and authors judgment)

UAB „SEB investicijų valdymas“	SEB Pensija 1 plius	90%	JP Morgan Global Bond index EMU
		10%	One month VILIBOR (indexed) - 50bp
	SEB Pensija 2 plius	17%	JP Morgan Global Bond Index EMU
		33%	MSCI Europe Index
		5%	MSCI Emerging markets
		45%	MSCI AC World Index
UAB „DnB NORD investicijų valdymas"	DnB Nord papildoma pensija	50%	Bloomberg/EFFAS Bond Indices Euro Govt (1-5Yr)
		20%	MSCI World Index
		20%	MSCI Europe Index
		10%	MSCI Emerging markets
	DnB Nord papildoma pensija 100	40%	MSCI World Index
		40%	MSCI Europe Index
		20%	MSCI Emerging markets
UAB „Citadele investicijų valdymas“	Citadele papildomas savanoriško pensijų kaupimo fondas	58%	Bloomberg/EFFAS Bond Indices Euro Govt (1-5Yr)
		12%	Euro Cash Indices Libor Total Return 3 Months Index
		30%	MSCI All Countries World Index (in EUR)
UAB „Finasta investicijų valdymas"	Finasta akciju pensija plius	95%	Msci Eastern Europe small cap index
		5%	Euro Cash Indices Libor Total Return 3 Months Index
	Finasta obligacijų pensija plius	70%	Bloomberg/EFFAS Bond Indices Euro Govt (1-5Yr)
		30%	Euro Cash Indices Libor Total Return 3 Months Index
UAB „MP Pension Funds Baltic"	MP MEDIO III	70%	MSCI All Countries World Index (in EUR).
		30%	JP Morgan Global Bond Index EMU
	MP EXTREMO III	100%	MSCI All Countries World Index (in EUR).
Swedbank Life Insurance SE	Pensija 1 plius	15%	MSCI All Countries World Index (in EUR).
		7%	MSCI Emerging markets
		10%	MSCI Europe Index
		3%	Euro Cash Indices Libor Total Return 3 Months Index
		65%	JP Morgan Global Bond Index EMU
	Pensija 2 plius	35%	JP Morgan Global Bond Index EMU
		4%	Euro Cash Indices Libor Total Return 3 Months Index
		14%	MSCI Emerging markets
		30%	MSCI All Countries World Index (in EUR).
		17%	MSCI Europe Index
	Pensija 3 plius	3%	Euro Cash Indices Libor Total Return 3 Months Index
		47%	MSCI All Countries World Index (in EUR).
		21%	MSCI Emerging markets
		29%	MSCI Europe Index

Data of monthly returns of chosen indices and calculated benchmarks are stated in Appendix A.

Further, for ratios calculation a risk free rate of return had to be defined. As a risk free rate of return author has chosen government obligations (VVP) of duration of 9 years with the properties indicated in the Table. Average monthly return being 0,39%.

Table 10: Properties of chosen VVP. (Source: Lietuvos Bankas)

Emission No.	ISIN	Duration, days	Currency	Date of the auction	Date of the purchase	Average return (%)
61101	LT0000611014	3086	LTL	2007 08 27	2016 02 10	4,718

All ratios were calculated using the excel calculators created by Martin Sewells and can be found in his internet web site.

The evaluation of performance based on basic risk-adjusted performance measures includes, in addition to its expected (mean) return, the associated risk. These performance measures differ principally with regard to whether they use total risk or systematic risk as the appropriate measure of risk. It has not yet been defined which measure best defines the risks so the best way to look at things is to calculate some and not only one ratio.

(3) Sharpe ratio. The reward-to-variability ratio (more commonly known as the Sharpe ratio) was introduced by William Sharpe in 1966. The Sharpe ratio defines excess return as the return above the risk free rate.

$$SR_i = \frac{\mu_i - r_f}{\sigma_i} \tag{17}$$

where, $(\mu_i - r_f)$ is expected excess return over the risk-free rate; (σ_i) - standard deviation of excess return (Scholz and Wilkens, 2005).

The Sharpe ratio is used to characterize how well the return of an asset compensates the investor for the risk taken, the higher the Sharpe ratio number, the better. The Sharpe ratio has as its principal advantage that it is directly computable from any observed series of returns without need for additional information surrounding the source of profitability. While the Treynor ratio works only with systematic risk of a portfolio, the Sharpe ratio observes both systematic and idiosyncratic risks.

(4) Treynor ratio. Was created by Treynor in 1966. It is a risk/return measure similar to the Sharpe ratio. It measures the return of the fund in excess of the risk-free return, per unit of risk that the fund adds to a well-diversified portfolio. The Treynor ratio uses the fund's beta (β), the systematic risk measure for calculation:

$$TR_i = \frac{\mu_i - r_f}{\beta_i} \tag{18}$$

where, $(\mu_i - r_f)$ is expected excess return over the risk-free rate; (β_i)- systemic risk. It is given by the ratio between the covariance of the fund's return and the market's return and the variance of the market's return (Casarin and Lazzarin, 2005). Like the Sharpe ratio, the Treynor ratio does not quantify the value added, if any, of active portfolio management. It is a ranking criterion only.

(5) Sortino ratio. The Sortino ratio was created by Sortino in 1991. It measures the return of the fund in excess of the MAR, per unit of downside deviation. It is a modification of the Sharpe ratio but penalizes only those returns falling below a user-specified target, or required rate of return, while the Sharpe ratio penalizes both upside and downside volatility equally. It is thus a measure of risk-adjusted returns that treats risk more realistically than the Sharpe ratio (Wikipedia, 2011).

$$S = \frac{R - T}{DR} \tag{19}$$

where, where R is the asset or portfolio realized return; T is the target or required rate of return for the investment strategy under consideration, (T shall be the same as the chosen risk free rate of return – that is 0,39%); DR is the downside risk.

(6) Information ratio. Originally referred to as the 'appraisal ratio'. It was introduced by Jack Treynor and Fischer Black in 1973. The IR defines excess return as the return in excess of a relevant benchmark index. The denominator of the IR is often referred to as a measure of 'tracking error'. Thus, the IR is often described as (a) residual return divided by residual risk or (b) alpha divided by residual risk. Whatever the definition, the higher the IR the better.

$$IR = \frac{E[R-R_b]}{\sigma} = \frac{\alpha}{\omega} = \frac{E[R-R_b]}{\sqrt{var[R-R_b]}} \quad (20)$$

where R is the portfolio return, Rb is the benchmark return, $\alpha = E[R - R_b]$ is the expected value of the active return, and σ is the standard deviation of the active return, which is an alternate definition of the aforementioned tracking error (Israelsen, 2005). One of the main criticisms of the Information ratio is that it considers arithmetic returns and ignores leverage. This can lead to the Information ratio calculated for a manager being negative when the manager produces alpha to the benchmark and vice-versa.

(7) Average yearly return. As investors use the term, the return an investment provides over a period of time, expressed as a time-weighted annual percentage. It is the de facto method for comparing the performance of investments also this is one of the most important criterion that individual investor would look at when investing to supplementary pension fund.

Table 11 summarizes the results of calculated ratios and average yearly returns for pension funds under consideration.

Table 11: Calculated ratios and average yearly return of supplementary pension funds. (Source: made by author)

	Sharpe ratio	**Treynor ratio**	**Sortino ratio**	**Information ratio**	**yearly returns (%)**
SEB Pensija 1 plius	0,044	-0,480	0,052	0,035	3,28
SEB Pensija 2 plius	-0,120	-0,804	-0,145	-0,056	4,16
DnB NORD papildoma pensija	-0,087	-0,336	-0,109	0,082	4,71
DnB NORD papildoma pensija 100"	-0,132	-1,046	-0,160	0,049	-3,45
Citadele papildomas savanoriško pensijų kaupimo fondas	-0,265	-2,241	-0,268	0,110	1,98
Finasta akcijų pensija plius	-0,258	-3,505	-0,274	-0,216	-3,92
Finasta obligacijų pensija pliu	0,346	5,977	0,696	0,253	6,90
MP MEDIO III	0,088	1,177	0,162	0,133	6,41
MP EXTREMO III	0,098	1,686	0,178	0,134	6,28
Swedbank Pensija 1 plius	-0,147	-0,389	-0,170	-0,108	2,03
Swedbank Pensija 2 plius	-0,132	-0,621	-0,159	-0,077	2,58
Swedbank Pensija 3 plius	-0,124	-0,937	-0,155	-0,054	-0,50

III. Fund descriptive parameters

(8) Fund size. It can influence investment performance positively or negatively, since, if on the one hand, greater size may increase trading power, seeking to obtain greater profitability, on the other hand, smaller size increases flexibility, providing greater agility in switching between investments. With the size of the fund comes power and ability to diversify more and reduce risks and large fund proponents suggest that small pension funds remain small simply because they are inferior performers. Further, larger fund size is associated with smaller expense percentages.

(9) Management fees. Pension funds are unique because most of their investment and administration activities are delegated to professional financial intermediaries. Investors

financial operation depends upon the specialist management skills of professional financial intermediaries. The fund administrators' expenses usually have an indirect effect (via charges and reduced assets to be invested) on the results of pension fund members. M.J. Brennan in his paper "Aspects of Insurance, Intermediation and Finance" (1993) shows that the existence of inelastic demand for financially intermediated services creates a wedge (intermediary spread) between the gross return realized on the portfolio by the intermediary and the net returns that are credited to the individual investor. That is why fees paid to management companies are an important evaluation factor. Certainly there is no need to overpay for these valuable services, but there is also no need to automatically reject a fund strictly on this basis.

(10) Minimal monthly installment. The sum that is minimally required to be imputed by the investor into the pension fund. It has to be a reasonable sum, affordable for a middle class investor. These are also important factors when evaluating the pension fund from investors' perspective.

(11) Up-load sum. It is the minimal amount required to be imputed into the pension fund when the investor wants to join it. If most pension funds required same amounts this would not be an evaluation criterions. But that is not the case in Lithuanian pension funds. Some up-load sums are so high that even overcomes the return on investment or the tenure of the management company if a person simply does not have the money needed. And that makes it a drawback of a pension fund because now it may have lost a client due to this factor.

(12) Conditions for switching funds. This criterion for pension fund is important because (in Lithuanian case) many of the supplementary pension funds have not existed more than 4 or 6 years. Which means that their performance results may be in some way deceitful and in the future everything may come around. And so the fund that looked very promising may not be performing so promising and an investor will feel a need to invest somewhere better. In that case he the conditions and payment included into switching funds or signing of supplementary pension funds in all is important. That is why these criteria have a weighting part in the evaluation model.

(13) Age of fund. Reasoning for selecting this criterion is not hard to understand. With the age of fund comes the trust, tenure, reputation. The longer the fund has existed the easier it is to see

how well it is managed and how reliable it is. For many financial advisors consider the fund manager's tenure an important attribute for estimating future performance.

As noted earlier. This criterion is not applicable to supplementary pension funds managed by Swedbank Life Insurance SE as this data is not available. Thus, in the Table 12 below the summary of third group of criteria is indicated.

Table 12: Summary of third group criteria data. (Source: made by author)

	Funds size, LTL	**Management fees, LTL**	**Minimal monthly instalment, LTL**	**Up load sum, LTL**	**Switching funds, %**	**Funds age (years)**
SEB „Pensija 1 plius“	13.510.766	3,2	50	30000	0,1	6
SEB „Pensija 2 plius“	44.586.779	4,2	50	30000	0,1	6
„DnB NORD papildoma pensija“	16.427.649	4,15	50	50	2	6
„DnB NORD papildoma pensija 100"	1.137.637	4,15	50	50	2	3
Citadele papildomas savanoriško pensijų kaupimo fondas	179.376	0,5	50	50	0	6
„Finasta akcijų pensija plius“	5.410.428	3,2	50	50	0	6
„Finasta obligacijų pensija plius“	1.660.981	1,3	50	50	0	6
MP MEDIO III	389.664	3,1	0	0	0,5	3
MP EXTREMO III	1.413.944	3,1	0	0	0,5	3
Pensija 1 plius	-	4,2	100	1000	0,2	5
Pensija 2 plius	-	4,2	100	1000	0,2	5
Pensija 3 plius	-	4,2	100	1000	0,2	5

<u>Stage 2:</u> applying AHP for determining relative criteria weightings. This involves five steps.

<u>Step 1</u>: Establish a hierarchical structure by breaking the pension fund selection problem into a hierarchy of interrelated decision elements, including the ultimate goal, criteria, and sub-criteria.

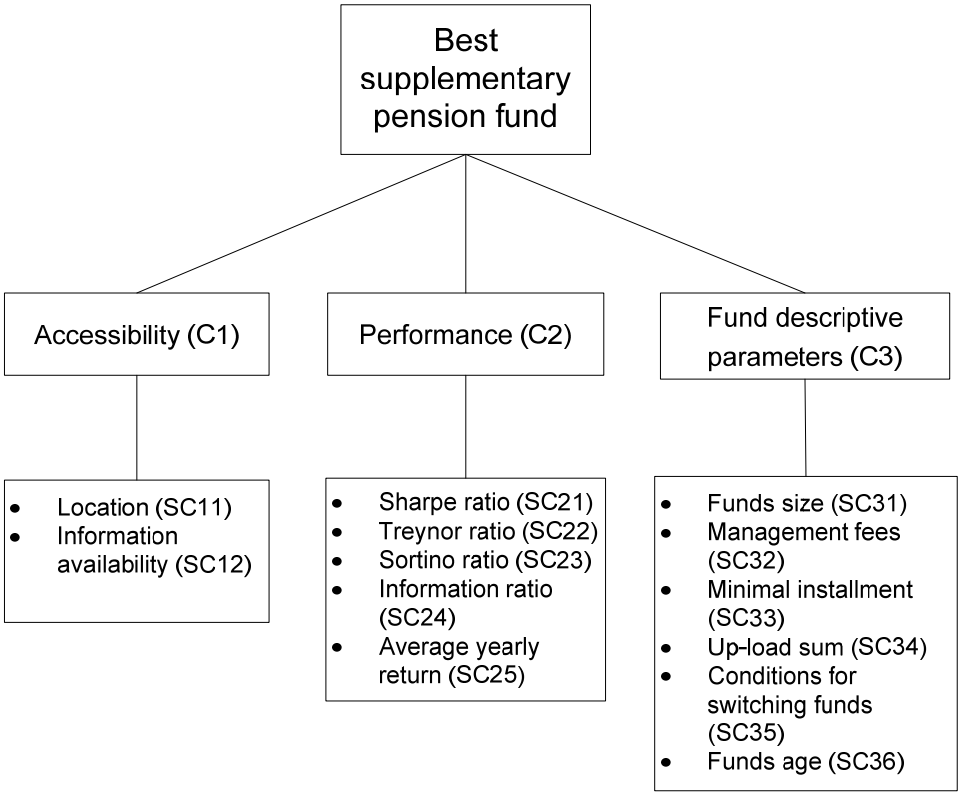

Figure 8: Hierarchical structure of supplementary pension funds evaluation and selection model. (Source: made by author).

In the Figure 8 above the hierarchical structure of composed supplementary funds evaluation model is identified. Above all criterion indicated, but in reality we will have two cases: one with all criteria but without funds managed by Swedbank Life Insurance SE; and another is without criterion 'Fund size' but including all supplementary pension funds. Now all the criteria have been defined and grouped. What is more, their shortened codes have been stated.

Step 2: Establish the pairwise comparison matrix using formula (1).

The relative investor, with certain objectives makes a pairwise comparison of the decision elements and gives them relative scores. Really, there is no standard way to make the pairwise comparison and in this paper, the questionnaire was established to help make that comparison and can be seen in Appendix C.

After giving relative scores, the pairwise matrices can be drawn up. The entries appearing in the diagonal are 1's because when a criterion is compared with the same criterion, there is no priority or inferiority. The non-zero whole numbers shown in tables are the weights of criteria shown in the left hand side over the criteria shown at the top. The reciprocal of any number shows the inferior weight of the left hand side criteria over the criteria shown at the top.

Table 13: Top level criteria pairwise matrix. (Source: made by author)

	C1	C2	C3
C1	1	1/8	1/3
C2	8	1	3
C3	3	1/3	1
Total	12	1,458	4,333

In Table 13 the top level criteria pairwise matrix is established. It can be seen that relative investor values supplementary pension fund performance (C2) the most over other two criteria. That is logical, since the goal of investing is to control the risks and to accumulate interest.

Table 14: C1 sub criteria pairwise matrix. (Source: made by author)

	SC11	SC12
SC11	1	2
SC12	1/2	1
Total	1,5	3

Table 14 gives us the sub-criteria of Availability of pension fund pairwise matrix. And Table 15 states the sub criteria of Performance criterion. It can be clearly seen that the yearly returns (SC25) of the supplementary pension fund is the most important factor for the relative investor. But an investor should not only judge upon this factor, thus, importance is assigned to most relevant ratios indicating the performance of the fund compared to the risks that the fund is undertaking.

Table 15: C2 sub criteria pairwise matrix. (Source: made by author)

	SC21	SC22	SC23	SC24	SC25
SC21	1	2	1/2	2	1/3
SC22	1/2	1	1/3	1	1/6
SC23	2	3	1	3	1/2
SC24	1/2	1	1/3	1	1/6
SC25	3	6	2	6	1
Total	7	13	4,167	13	2,167

Table 16 indicates the pairwise matrix of Descriptive parameters sub criteria. As indicated earlier in the paper, fund administrators' expenses usually have an indirect effect on the results of pension fund members, thus, most weight is given to this particular criterion. None the less, other factors contribute as much to the whole evaluation and decision making.

Table 16: C3 sub criteria pairwise matrix. (Source: made by author)

	SC32	**SC33**	**SC34**	**SC35**	**SC36**
SC32	1	7	5	9	3
SC33	1/7	1	1	2	1/4
SC34	1/5	1	1	3	1/3
SC35	1/9	1/2	1/3	1	1/5
SC36	1/3	4	3	5	1
Total	1,787	13,5	10,333	20	4,783

Step 3: Calculate the eigenvector of each pairwise comparison matrix using approximation suggested by Saaty (2008).

To determine the priority of each of the decision elements using the pairwise comparison information these calculations have to be made: 1) Sum each column of the pairwise comparison matrix, divide each element of that column by the column sum, and the result is the normalized comparison matrix. 2) Calculate the average of each row of the normalized comparison matrix, the resulting averages provide the relative priority of the decision elements matching to the rows of the matrix.

Table 17: Top level criteria eigenvector. (Source: made by author)

	C1	**C2**	**C3**	**Priority vector**
C1	0,083333	0,085714	0,076923	0,0820
C2	0,666667	0,685714	0,692308	0,6816
C3	0,25	0,228571	0,230769	0,2364

Table 18: C1 sub criteria eigenvector. (Source: made by author)

	SC11	SC12	Priority vector
SC11	0,666667	0,666667	0,6667
SC12	0,333333	0,333333	0,3333

The calculated eigenvectors show the importance of certain criterion within its group. The results are in Tables 17, 18, 19, 20 and they are the result of the approximation described above. The priority vector (or eigenvector) corresponds to the importance given by the relative investor to the criteria.

Table 19: C2 sub criteria eigenvector. (Source: made by author)

	SC21	SC22	SC23	SC24	SC25	Priority vector
SC21	0,142857	0,153846	0,12	0,153846	0,153846	0,1449
SC22	0,071429	0,076923	0,08	0,076923	0,076923	0,0764
SC23	0,285714	0,230769	0,24	0,230769	0,230769	0,2436
SC24	0,071429	0,076923	0,08	0,076923	0,076923	0,0764
SC25	0,428571	0,461538	0,48	0,461538	0,461538	0,4586

Table 20: C3 sub criteria eigenvector. (Source: made by author)

	SC32	SC33	SC34	SC35	SC36	Priority vector
SC32	0,559503	0,518519	0,483871	0,45	0,627178	0,5278
SC33	0,079929	0,074074	0,096774	0,1	0,052265	0,0806
SC34	0,111901	0,074074	0,096774	0,15	0,069686	0,1005
SC35	0,062167	0,037037	0,032258	0,05	0,041812	0,0447
SC36	0,186501	0,296296	0,290323	0,25	0,209059	0,2464

The most important within the top criteria level is given to performance criterion and the score is 0,6816. The most important factors within sub criteria are: from C1 it is location with score 0,6667; from C2 it is average yearly returns with the score 0,4586; from C3 it is management fees and the score is 0,5278.

Step 4: Test the consistency of each comparison matrix using formulas (4)-(5)-(6).

Unfortunately, investors seldom understand their own preferences fully and often rank their preferences inconsistently. By itself, a questionnaire cannot identify such inconsistencies. No financial advisor could recommend funds "suitable" for the investor because of the inconsistent preference ranking. The AHP enables to identify any inconsistencies by overgoing inconsistency calculation for any composed matrices.

In the Table 21 below all necessary indicators and consistency ratio itself are calculated and indicated.

Table 21: Consistency calculation data for all criteria and sub criteria. (Source: made by author)

	Top level criteria	**C1 sub criteria**	**C2 sub criteria**	**C3 sub criteria**
RI	0,58	0	1,15	1,15
λmax	3,002432	2	5,010315	5,141823
CI	0,001216	0	0,002579	0,035456
CR	**0,002096**	**0**	**0,002302**	**0,031657**
n	3	2	5	5

For n=3 the required consistency ratio (CR) should be less than 0.05, thus top level criteria have been ranked in a suitable manner as its CR is 0,002; for $n \geq 5$ it should be less than 0.10 to get a sufficient consistent matrix, thus performance (CR= 0,002) and descriptive criteria (CR= 0,03) matrices are consistent and the relative investor has indicated his preferences correctly. CR with n=2 will always be zero as this matrix cannot be inconsistent.

Step 5: Estimate the global weights of the elements of each level.

For further calculations it is needed to calculate the global weight of each criterion. This is useful not only for the calculations but also in order to see the most important criteria in the whole. The global weights are calculated very simply. For example, in order to calculate the global weight of Sharpe ratio we simple multiply sub criterions Sharpe ratios relative weight with the relative weight of the main criterion that it belongs to (like this: (Performance criterion) 0,6816 x (Sharpe ratio) 0,1449 and the result is 0,0987).

Table 22: Global weights for factor excluding criterion 'Fund size'. (Source: made by author)

Criteria	Abv.	Weight	Sub-criteria	Abv.	Weight	Gglobal weight
			Locations	**SC11**	0,6667	**0,0547**
			Information availibility	**SC12**	0,3333	**0,0273**
			Sharpe ratio	**SC21**	0,1449	**0,0987**
			Treynor ratio	**SC22**	0,0764	**0,0521**
Availibility	*C1*	0,0820	Sortino ratio	**SC23**	0,2436	**0,1660**
Performance	*C2*	0,6816	Information ratio	**SC24**	0,0764	**0,0521**
Requirements	*C3*	0,2364	Average yearly return	**SC25**	0,4586	**0,3126**
			Management fees	**SC32**	0,5278	**0,1248**
			Min. monthly installment	**SC33**	0,0806	**0,0191**
			Up load sum	**SC34**	0,1005	**0,0238**
			Switching funds	**SC35**	0,0447	**0,0106**
			Funds age	**SC36**	0,2464	**0,0583**

From Table 22 it can be seen that according to the relative investor the main criterions are average yearly returns (0,3126), Sortino ratio (0,166), Management fees (0,1248) and so on.

The same steps have been applied to the hierarchy with all defined criteria (calculations can be seen in Appendix B) and the Table 23 below summarizes the results.

Table 23: Global weights for all chosen criterion. (Source: made by author)

Criteria	Abv.	Weight	Consistency (CR)	Sub-criteria	Abv.	Weight	Gglobal weight
				Locations	**SC11**	0,6667	**0,0547**
			0,0000	Information availibility	**SC12**	0,3333	**0,0273**
				Sharpe ratio	**SC21**	0,1449	**0,0987**
				Treynor ratio	**SC22**	0,0764	**0,0521**
Availibility	*C1*	0,0820		Sortino ratio	**SC23**	0,2436	**0,1660**
Performance	*C2*	0,6816		Information ratio	**SC24**	0,0764	**0,0521**
Requirements	*C3*	0,2364	0,0023	Average yearly return	**SC25**	0,4586	**0,3126**
				Funds size	**SC31**	0,0337	**0,0080**
				Management fees	**SC32**	0,3950	**0,0934**
				Min monthly inst.	**SC33**	0,0999	**0,0236**
				Up load sum	**SC34**	0,1307	**0,0309**
				Switching funds	**SC35**	0,0542	**0,0128**
			0,0441	Funds age	**SC36**	0,2865	**0,0677**

From the results it is clear that the criterion fund size (global weight is only 0,008) for this particular relative investor is the least important criterion and most likely will not make any significant changes in the ranking of most suitable supplementary pension funds.

Staged 3: applying GRA to determine the weights of supplementary pension funds performance. This GRA model involves five steps.

Step 6: Define the criteria and data treatment. Compose data series as done in equation (8).

For further calculations the collected data of all chosen criterion shall be used. It will be used in a form of table. Data as shown in the Table 24.

Table 24: Data for all 13 chosen criteria.

	Funds age (years) SC36	Switching funds % SC35	Up load sum LTL SC34	Minimal monthly instalment LTL SC33	Management fees LTL SC32	Funds size LTL SC31	Average yearly return (%) SC25	Information ratio SC24	Sortino ratio SC23	Treynor ratio SC22	Sharpe ratio SC21	Availibility of information SC12	Locations SC11
SEB Pensija 1 plius **(X1)**	6	0,1	30000	50	3,2	13510766	3,28	0,035	0,052	-0,48	0,044	16	57
SE Pensija 2 plius **(X2)**	6	0,1	30000	50	4,2	44586779	4,16	-0,056	-0,145	-0,804	-0,12	16	57
DnB NORD papildoma pensija **(X3)**	6	2	50	50	4,15	16427649	4,71	0,082	-0,109	-0,336	-0,087	17	85
DnB NORD papildoma pensija 100 **(X4)**	3	2	50	50	4,15	1137637	-3,45	0,049	-0,16	-1,046	-0,132	17	85
Citadele papildomas savanoriškas pensijų kaupimo fondas **(X5)**	6	0	50	50	0,5	179376	1,98	0,11	-0,268	-2,241	-0,265	12	15
Finasta akcijų pensija plius **(X6)**	6	0	50	50	3,2	5410428	-3,92	-0,216	-0,274	-3,505	-0,258	17	3
Finasta obligacijų pensija plius **(X7)**	6	0	50	50	1,3	1660981	6,9	0,253	0,696	5,977	0,346	17	3
MP MEDIO III **(X8)**	3	0,5	0	0	3,1	389664	6,41	0,133	0,162	1,177	0,088	16	3
MP EXTREMO III **(X9)**	3	0,5	0	0	3,1	1413944	6,28	0,134	0,178	1,686	0,098	16	3
Swedbank Pensija 1 plius **(X10)**	5	0,2	1000	100	4,2	-	2,03	-0,108	-0,17	-0,389	-0,147	16	98
Swedbank Pensija 2 plius **(X11)**	5	0,2	1000	100	4,2	-	2,58	-0,077	-0,159	-0,621	-0,132	16	98
Swedbank Pensija 3 plius **(X12)**	5	0,2	1000	100	4,2	-	-0,5	-0,054	-0,155	-0,937	-0,124	16	98

Table 25: Data series, excluding criterion 'Fund size'. (Source: made by author)

	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC32	SC33	SC34	SC35	SC36
X1	57	16	0,044	-0,480	0,052	0,035	3,28	3,2	50	30000	0,1	6
X2	57	16	-0,120	-0,804	-0,145	-0,056	4,16	4,2	50	30000	0,1	6
X3	85	17	-0,087	-0,336	-0,109	0,082	4,71	4,15	50	50	2	6
X4	85	17	-0,132	-1,046	-0,160	0,049	-3,45	4,15	50	50	2	3
X5	15	12	-0,265	-2,241	-0,268	0,110	1,98	0,5	50	50	0	6
X6	3	17	-0,258	-3,505	-0,274	-0,216	-3,92	3,2	50	50	0	6
X7	3	17	0,346	5,977	0,696	0,253	6,90	1,3	50	50	0	6
X8	3	16	0,088	1,177	0,162	0,133	6,41	3,1	0	0	0,5	3
X9	3	16	0,098	1,686	0,178	0,134	6,28	3,1	0	0	0,5	3
X10	98	16	-0,147	-0,389	-0,170	-0,108	2,03	4,2	100	1000	0,2	5
X11	98	16	-0,132	-0,621	-0,159	-0,077	2,58	4,2	100	1000	0,2	5
X12	98	16	-0,124	-0,937	-0,155	-0,054	-0,50	4,2	100	1000	0,2	5

Table 25 above indicates the form of the table that will be used further on in this paper. This is excluding criterion 'Fund size' so that the change of numbers could be seen for all supplementary pension funds in question. It is with shortened codes (for ease of calculations). Here data is not yet normalized to the scale from 0 to 1 and is in its raw original form. How these numbers were retrieved is explained in the beginning of this chapter.

Step 7: Determine the referential series using formula (8).

The referential series is basically the 'perfect series' it includes all the best results of all supplementary pension funds. The referential series is composed by applying criterions 'larger the better' or 'smaller the better'. For example: for average yearly returns (SC25) the case of 'larger the better' is the appropriate one, thus, the result of the best yearly returns is chosen and it is that of Finasta obligacijų pensija plius and is 6,9 %. In the case of criterion management fees (SC32) the case of smaller the better' is the right one. In this case we choose that with 0. Table 26 indicates the case under which the certain number was chosen and forms a referential series.

Table 26: Referential series X_0. (Source: made by author)

SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC32	SC33	SC34	SC35	SC36
MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MIN**	**MIN**	**MIN**	**MIN**	**MAX**
98	17	0,346	5,977	0,696	0,253	6,9	0,5	0	0	0	6

Step 8: Normalize individual criteria values using formulas (9) and (10) to obtain $x_i^*(k)$.

The series data in this case can also be treated using these two approaches: 'larger-is-better' and 'smaller-is-better'. Which criterion applies which case is shown on the top of the Table 27. Normalization is made to transform all data to a range from 0 to 1, in order to make adequate calculations.

Table 27: Normalized data (excluding 'Fund size'). (Source: made by author)

	MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MIN**	**MIN**	**MIN**	**MIN**	**MAX**
	SC11	**SC12**	**SC21**	**SC22**	**SC23**	**SC24**	**SC25**	**SC32**	**SC33**	**SC34**	**SC35**	**SC36**
X1	0,568	0,800	0,505	0,319	0,336	0,535	0,665	0,270	0,500	0,000	0,950	1,000
X2	0,568	0,800	0,237	0,285	0,133	0,343	0,747	0,000	0,500	0,000	0,950	1,000
X3	0,863	1,000	0,291	0,334	0,170	0,637	0,798	0,014	0,500	0,998	0,000	1,000
X4	0,863	1,000	0,217	0,259	0,117	0,565	0,043	0,014	0,500	0,998	0,000	0,000
X5	0,126	0,000	0,000	0,133	0,006	0,696	0,546	1,000	0,500	0,998	1,000	1,000
X6	0,000	1,000	0,011	0,000	0,000	0,000	0,000	0,270	0,500	0,998	1,000	1,000
X7	0,000	1,000	1,000	1,000	1,000	1,000	1,000	0,784	0,500	0,998	1,000	1,000
X8	0,000	0,800	0,578	0,494	0,449	0,744	0,955	0,297	1,000	1,000	0,750	0,000
X9	0,000	0,800	0,593	0,547	0,466	0,748	0,943	0,297	1,000	1,000	0,750	0,000
X10	1,000	0,800	0,193	0,329	0,107	0,230	0,550	0,000	0,000	0,967	0,900	0,667
X11	1,000	0,800	0,218	0,304	0,119	0,298	0,601	0,000	0,000	0,967	0,900	0,667
X12	1,000	0,800	0,230	0,271	0,123	0,345	0,316	0,000	0,000	0,967	0,900	0,667

Normalization is made with the reference to the referential series. The so called 'perfect series'. Thus the best performing supplementary pension fund under certain criterion shall get the score 1 and the least performing shall get score 0. Others shall get numbers in-between.

Whereas, the referential series X_0 becomes as indicated in Table 28 below.

Table 28: Normalized referential series (excluding 'Fund size'). (Source: made by author)

SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC32	SC33	SC34	SC35	SC36
MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MIN**	**MIN**	**MIN**	**MIN**	**MAX**
1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Step 9: Calculate difference series$\Delta_{0i}(k)$.

The difference series $[\Delta_{0i}(k)]$ is the absolute value of difference between the reference series data and the compared series data and it plays a vital role for finding the Δ_i of individual compared series and to find the grey relation grade. The results are in Table 29.

Table 29: Difference series. (Source: made by author)

	SC11	**SC12**	**SC21**	**SC22**	**SC23**	**SC24**	**SC25**	**SC32**	**SC33**	**SC34**	**SC35**	**SC36**
X1	0,432	0,200	0,495	0,681	0,664	0,465	0,335	0,730	0,500	1,000	0,050	0,000
X2	0,432	0,200	0,763	0,715	0,867	0,657	0,253	1,000	0,500	1,000	0,050	0,000
X3	0,137	0,000	0,709	0,666	0,830	0,363	0,202	0,986	0,500	0,002	1,000	0,000
X4	0,137	0,000	0,783	0,741	0,883	0,435	0,957	0,986	0,500	0,002	1,000	1,000
X5	0,874	1,000	1,000	0,867	0,994	0,304	0,454	0,000	0,500	0,002	0,000	0,000
X6	1,000	0,000	0,989	1,000	1,000	1,000	1,000	0,730	0,500	0,002	0,000	0,000
X7	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,216	0,500	0,002	0,000	0,000
X8	1,000	0,200	0,422	0,506	0,551	0,256	0,045	0,703	0,000	0,000	0,250	1,000
X9	1,000	0,200	0,407	0,453	0,534	0,252	0,057	0,703	0,000	0,000	0,250	1,000
X10	0,000	0,200	0,807	0,671	0,893	0,770	0,450	1,000	1,000	0,033	0,100	0,333
X11	0,000	0,200	0,782	0,696	0,881	0,702	0,399	1,000	1,000	0,033	0,100	0,333
X12	0,000	0,200	0,770	0,729	0,877	0,655	0,684	1,000	1,000	0,033	0,100	0,333

Step 10: Calculate the relational coefficients, $\Upsilon_{0i}(k)$ of the compared series using formula (14).

Using the formula (14) we can calculate the relational coefficients. As suggested in all of the articles the distinguished coefficient ξ_Δ shall be 0,5 (it has to be belong to [0,1]). After putting all the now known's, the following Table 30 was composed.

Table 30: Relational coefficients. (Source: made by author)

	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC32	SC33	SC34	SC35	SC36
X1	0,537	0,714	0,503	0,423	0,430	0,518	0,599	0,407	0,500	0,333	0,909	1,000
X2	0,537	0,714	0,396	0,411	0,366	0,432	0,664	0,333	0,500	0,333	0,909	1,000
X3	0,785	1,000	0,414	0,429	0,376	0,579	0,712	0,336	0,500	0,997	0,333	1,000
X4	0,785	1,000	0,390	0,403	0,362	0,535	0,343	0,336	0,500	0,997	0,333	0,333
X5	0,364	0,333	0,333	0,366	0,335	0,622	0,524	1,000	0,500	0,997	1,000	1,000
X6	0,333	1,000	0,336	0,333	0,333	0,333	0,333	0,407	0,500	0,997	1,000	1,000
X7	0,333	1,000	1,000	1,000	1,000	1,000	1,000	0,698	0,500	0,997	1,000	1,000
X8	0,333	0,714	0,542	0,497	0,476	0,662	0,917	0,416	1,000	1,000	0,667	0,333
X9	0,333	0,714	0,551	0,525	0,484	0,665	0,897	0,416	1,000	1,000	0,667	0,333
X10	1,000	0,714	0,383	0,427	0,359	0,394	0,526	0,333	0,333	0,938	0,833	0,600
X11	1,000	0,714	0,390	0,418	0,362	0,416	0,556	0,333	0,333	0,938	0,833	0,600
X12	1,000	0,714	0,394	0,407	0,363	0,433	0,422	0,333	0,333	0,938	0,833	0,600

<u>Stage 4:</u> combining AHP and GRA to select the best supplementary pension fund for investor with predefined goals.

<u>Step 11:</u> Compute the relational grade, Γ_{oi}, by combining AHP and GRA and using formula (16).

The grey relational grade corresponds to the correlation between two series. It is not important in decision-making. Rather, the ranking order of the relational grade is the most important information.

Table 31: GRA relational grade (excluding 'Fund size'). (Source: made by author)

	Locations	Availibility of information	Sharpe ratio	Treynor ratio	Sortino ratio	Information ratio	Average yearly return (%)	Management fees LTL	Minimal monthly instalment LTL	Up load sum LTL	Switching funds %	Funds age (years)
	SC11	**SC12**	**SC21**	**SC22**	**SC23**	**SC24**	**SC25**	**SC32**	**SC33**	**SC34**	**SC35**	**SC36**
	0,055	**0,027**	**0,099**	**0,052**	**0,166**	**0,052**	**0,313**	**0,125**	**0,019**	**0,024**	**0,011**	**0,058**
X1	0,029	0,020	0,050	0,022	0,071	0,027	0,187	0,051	0,010	0,008	0,010	0,058
X2	0,029	0,020	0,039	0,021	0,061	0,023	0,207	0,042	0,010	0,008	0,010	0,058
X3	0,043	0,027	0,041	0,022	0,062	0,030	0,223	0,042	0,010	0,024	0,004	0,058
X4	0,043	0,027	0,038	0,021	0,060	0,028	0,107	0,042	0,010	0,024	0,004	0,019
X5	0,020	0,009	0,033	0,019	0,056	0,032	0,164	0,125	0,010	0,024	0,011	0,058
X6	0,018	0,027	0,033	0,017	0,055	0,017	0,104	0,051	0,010	0,024	0,011	0,058
X7	0,018	0,027	0,099	0,052	0,166	0,052	0,313	0,087	0,010	0,024	0,011	0,058
X8	0,018	0,020	0,054	0,026	0,079	0,034	0,287	0,052	0,019	0,024	0,007	0,019
X9	0,018	0,020	0,054	0,027	0,080	0,035	0,280	0,052	0,019	0,024	0,007	0,019
X10	0,055	0,020	0,038	0,022	0,060	0,021	0,165	0,042	0,006	0,022	0,009	0,035
X11	0,055	0,020	0,039	0,022	0,060	0,022	0,174	0,042	0,006	0,022	0,009	0,035
X12	0,055	0,020	0,039	0,021	0,060	0,023	0,132	0,042	0,006	0,022	0,009	0,035

In the Table 31 of the relational grades the best grades are marked in red; second best are marked in green; third best are marked in blue. This is done to identify any tendencies in the results of supplementary pension funds. And certain tendencies can be seen looking at these markings. These shall be discussed in the last step.

Step 12: Select the top gray relational grades Γ_{oi}; which is the most suitable supplementary pension fund.

According to GRA, the alternative with the highest grey relational grade is the most important (or optimal) alternative (Wu and Chen, 1999). Therefore, in this study, the priorities of supplementary pension funds can be ranked in accordance with the grey relational grade values because the relative weights $W_i(j)$ of evaluative criteria are determined using AHP. This value of grey relation is the overall performance of Lithuanian supplementary pension funds.

Table 32: Total scores of supplementary pension funds. (Source: made by author)

Supplementary pension fund	**Total Score**	**Place**
SEB Pensija 1 plius **(X1)**	0,5422	6
SE Pensija 2 plius **(X2)**	0,5270	7
DnB NORD papildoma pensija **(X3)**	0,5855	4
DnB NORD papildoma pensija 100 **(X4)**	0,4231	12
Citadele papildomas savanoriškas pensijų kaupimo fondas **(X5)**	0,5595	5
Finasta akcijų pensija plius **(X6)**	0,4258	11
Finasta obligacijų pensija plius **(X7)**	0,9163	1
MP MEDIO III **(X8)**	0,6386	2
MP EXTREMO III **(X9)**	0,6360	3
Swedbank Pensija 1 plius **(X10)**	0,4928	9
Swedbank Pensija 2 plius **(X11)**	0,5040	8
Swedbank Pensija 3 plius **(X12)**	0,4631	10

The overall scores and ranks are identified in Table 32. The clear best performer is Finasta obligacijų pensija plius (0,9163). As was seen from previous Table it had best performance scores in more than half of the criteria, thus leaving other pension funds far behind. Second places is to be given to MP MEDIO III (0,6386) and third to the pension fund managed by the same management company and it goes to MP EXTREMO III (0,6360). More discussion on the results shall be carried on in the last part of this chapter.

For the sake of comparison below are calculations without supplementary pension funds managed by Swedbank Life Insurance SE, but with all criteria. The three main parts are shown: the referential series, normalized data and relational grade and everything is concluded in the final, total score, Table 36.

Table 33: Referential series X_0 of all criteria. (Source: made by author)

SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC31	SC32	SC33	SC34	SC35	SC36
MAX	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MAX**	**MIN**	**MIN**	**MIN**	**MIN**	**MAX**
85	17	0,346	5,977	0,696	0,253	6,9	44586779	0,5	0	0	0	6

Table 34: Normalized data of all criteria. (Source: made by author)

	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MAX	MIN	MIN	MIN	MIN	MAX
	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC31	SC32	SC33	SC34	SC35	SC36
X1	0,659	0,800	0,505	0,319	0,336	0,535	0,665	0,300	0,270	0,000	0,000	0,950	1,000
X2	0,659	0,800	0,237	0,285	0,133	0,343	0,747	1,000	0,000	0,000	0,000	0,950	1,000
X3	1,000	1,000	0,291	0,334	0,170	0,637	0,798	0,366	0,014	0,000	0,998	0,000	1,000
X4	1,000	1,000	0,217	0,259	0,117	0,565	0,043	0,022	0,014	0,000	0,998	0,000	0,000
X5	0,146	0,000	0,000	0,133	0,006	0,696	0,546	0,000	1,000	0,000	0,998	1,000	1,000
X6	0,000	1,000	0,011	0,000	0,000	0,000	0,000	0,118	0,270	0,000	0,998	1,000	1,000
X7	0,000	1,000	1,000	1,000	1,000	1,000	1,000	0,033	0,784	0,000	0,998	1,000	1,000
X8	0,000	0,800	0,578	0,494	0,449	0,744	0,955	0,005	0,297	1,000	1,000	0,750	0,000
X9	0,000	0,800	0,593	0,547	0,466	0,748	0,943	0,028	0,297	1,000	1,000	0,750	0,000

Table 35: GRA relational grade for all criteria. (Source: made by author)

	Locations	Availibility of information	Sharpe ratio	Treynor ratio	Sortino ratio	Information ratio	Average yearly return (%)	Funds size LTL	Management fees LTL	Minimal monthly instalment LTL	Up load sum LTL	Switching funds %	Funds age (years)
	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC31	SC32	SC33	SC34	SC35	SC36
	0,055	**0,027**	**0,099**	**0,052**	**0,166**	**0,052**	**0,313**	**0,008**	**0,098**	**0,023**	**0,030**	**0,013**	**0,065**
X1	0,032	0,020	0,050	0,022	0,071	0,027	0,187	0,003	0,040	0,008	0,010	0,011	0,065
X2	0,032	0,020	0,039	0,021	0,061	0,023	0,207	0,008	0,033	0,008	0,010	0,011	0,065
X3	0,055	0,027	0,041	0,022	0,062	0,030	0,223	0,003	0,033	0,008	0,030	0,004	0,065
X4	0,055	0,027	0,038	0,021	0,060	0,028	0,107	0,003	0,033	0,008	0,030	0,004	0,022
X5	0,020	0,009	0,033	0,019	0,056	0,032	0,164	0,003	0,098	0,008	0,030	0,013	0,065
X6	0,018	0,027	0,033	0,017	0,055	0,017	0,104	0,003	0,040	0,008	0,030	0,013	0,065
X7	0,018	0,027	0,099	0,052	0,166	0,052	0,313	0,003	0,069	0,008	0,030	0,013	0,065
X8	0,018	0,020	0,054	0,026	0,079	0,034	0,287	0,003	0,041	0,023	0,030	0,008	0,022
X9	0,018	0,020	0,054	0,027	0,080	0,035	0,280	0,003	0,041	0,023	0,030	0,008	0,022

Table 36: Total scores of supplementary pension funds. (Source: made by author)

Supplementary pension fund	Total Score	Place
SEB Pensija 1 plius	0,5465	6
SEB Pensija 2 plius	0,5378	7
DnB NORD papildoma pensija	0,6036	4
DnB NORD papildoma pensija 100	0,4358	8
Citadele papildomas savanoriškas pensijų kaupimo fondas	0,5489	5
Finasta akcijų pensija plius	0,4309	9
Finasta obligacijų pensija plius	0,9135	1
MP MEDIO III	0,6438	2
MP EXTREMO III	0,6413	3

Table 36 clearly indicates the idea discussed earlier – that the additional criterion 'Fund size' shall not make any big changes in the hierarchy of the supplementary pension funds. And it is clear now – it did not. The same top 5 supplementary pension funds remain in their same places and their total scores are more or less the same: Finasta obligacijų pensija plius (0,9135); second places is to be given to MP MEDIO III (0,6438) and third to the pension fund managed by the same management company and it goes to MP EXTREMO III (0,6413). The changed occurred only in the last to places where DnB NORD papildoma pensija 100 (0,4358) overperformed Finasta akcijų pensija plius (0,4309) and left it in the last place. Whereas, in the previous evaluation DnB NORD papildoma pensija 100 was the supplementary pension fund that has shown worst results in the evaluation.

4.2. Results of evaluation

The supplementary pension funds evaluation model developed here structures the evaluation and selection problem in a hierarchical form and linked performance measures, descriptive parameters and the overall availability of pension funds. In addition, the model combines two different approaches developed in the literature. In obtaining the overall performance score, the multi-criteria approach combines the measured things values at separate measures. Without applying a multi-criteria approach, it is not possible to overcome the problem of heterogeneity of the measurement units that makes it difficult to assess and compare different supplementary pension funds.

Finasta obligacijų pensija plius is the optimal supplementary pension fund within all evaluated supplementary pension funds if both qualitative and quantitative criteria are taken into account. It is noted that the ranking order will change with respect to change in weighting value for each criterion. In other words, it all depends on individual investor's goals and requirements. Three different individual investors may actually get different results.

Below is the accumulated table of results, including both: results with all criteria and results excluding criterion 'Fund size'.

Table 37: Supplementary pension funds: from 1st to last. (Source: made by author)

Supplementary pension fund	**Total Score**	**Place**	**Place (without Swedbank pension funds)**
Finasta obligacijų pensija plius	0,916	1	1
MP MEDIO III	0,639	2	2
MP EXTREMO III	0,636	3	3
DnB NORD papildoma pensija	0,586	4	4
Citadele papildomas savanoriškas pensijų kaupimo fondas	0,56	5	5
SEB Pensija 1 plius	0,542	6	6
SEB Pensija 2 plius	0,527	7	7
Swedbank Pensija 2 plius	0,504	8	-
Swedbank Pensija 1 plius	0,493	9	-
Swedbank Pensija 3 plius	0,463	10	-
Finasta akcijų pensija plius	0,426	11	9
DnB NORD papildoma pensija 100	0,423	12	8

Let's not forget that the particular results of the evaluation have been obtained based on the preferences of the relative individual investor with certain predefined goals (these can be seen in the pairwise matrices and in filled questionnaires). The chosen relative investor has more than 35 years left to his retirement and gives great value to the performance criteria of supplementary pension funds. What is more, he prefers riskier investment over that with little risks. Thus, it is needed to look at the bigger picture – look at pension fund in their risk groups. This is done in the Table 38 below.

Table 38: Supplementary pension funds listing in their risk groups. (Source: made by author)

Supplementary pensipn fund	Score	Place	Score	Place (without Swedbank pension funds)
Investing in securities				
Finasta obligacijų pensija plius	0,916	1	0,9135	1
Mixed investment strategy				
DnB NORD papildoma pensija	0,586	2	0,6036	2
MP MEDIO III	0,639	1	0,6438	1
Citadele papildomas savanoriškas pensijų kaupimo fondas	0,56	3	0,5489	3
SEB pensija 1 plius	0,542	4	0,5465	4
Swedbank pensija 1 plius	0,493	6	-	-
Swedbank pensija 2 plius	0,504	5	-	-
Investing in shares				
DnB NORD papildoma pensija 100	0,423	5	0,4358	3
Finasta akcijų pensija plius	0,426	4	0,4309	4
MP EXTREMO III	0,636	1	0,6413	1
SEB pensija 2 plius	0,527	2	0,5378	2
Swedbank pensija 3 plius	0,463	3	-	-

All three to criteria belong to different risk supplementary pension funds. After dividing into groups the results are these:

In the least risky investing strategy group (investing in securities) the best result belongs to our overall best performer Finasta obligacijų pensija plius. But actually this is the only supplementary pension fund that has chosen such a riskless type of investment (but we know that such thing as riskless investment does not exist). There are two main reasons why this particular pension fund had best results: the longest living pension fund is only as old as 6 years – this is a period too short to show any stable results and funds that have existed 2 years maybe trusted as much. Second, and main reason, is that period used to calculate all ratios (the last three years) have been the years of the global financial crisis that has adversely effected all investments – especially the risky ones. Thus this least risky fund had all the best conditions to survive the crises with results least intacted.

The second group of supplementary pension funds is the one containing the moderate risk investments or the ones using mixed investment strategy. Here the fund that outperformed all the

others is MP MEDIO III supplementary pension fund. If looking at the result including all evaluation criteria then DnB NORD papildoma pensija shows almost equal performance as this is the second largest (in asset size) supplementary pension fund and it adds to the total score.

The third group is taking the most risky investment decisions it is investing mostly in company's shares. Again – this is promising the greatest returns, but also taking up greatest risks. Actually the tendency can be seen that all the supplementary pension funds belonging to this group are lining in the end of the total evaluation (when not divided in groups). This is logical, and as explained earlier, this is due to the abnormal market conditions – the financial crises – these funds have shown the worst results. But is not necessarily bad as this group is for long term investment allowing for fluctuations and in the end still being able to bring what they have promised. If this evaluation was done two years ago or two years in the future, it is sure that results would be much different and supplementary pension funds from this group would be on the top of the list. Continuing, the best performing pension fund in this group is MP EXTREMO III. It is a clear leader leaving other pension funds behind by at least 0,1 points.

The results support the theory raised earlier in the paper that a lot of people choose where to invest only by following the masses and choosing the best known or advertised brand name. But actually supplementary pension funds managed by UAB „SEB investicijų valdymas" did not show very good results according to the chosen evaluation criteria. Even though these pension funds have the most participants and the greatest assets. The best results were shown by the companies that are not big banks and that are concentrated mainly into the activity of investing. Actually, UAB „MP Pension Funds Baltic", that manages MP MEDIO and MP EXTREMO supplementary pension funds is dedicated entirely to the management of pension funds (second pillar and supplementary pension funds) thus proving that the experience and orientation into certain goals brings more use, results and is trustworthy no matter what the general public chooses.

The chosen relative individual investor should choose to invest into MP EXTREMO III supplementary pension fund. Firstly, because this fund is the best performing fund in the group investing in shares, as this supports the investor wish of taking more risk given that investor has more than 35 years left to his retirement. Secondly, this pension fund very well represents relative investors preference for supplementary pension funds performance ratios and yearly returns as under C2 criteria this fund had all second highest results (Finasta obligacijų pensija plius was first in all of them). What is more, it had the lowest management fees. The weak side of the MP EXTREMO III supplementary pension fund is that it is available only in three cities, but then again, the relative investor was not very concerned about this criterion (can be seen from the global weight

assigned to it). Most definitely, in the case of another investor with, for example, great preferences for availability of pension fund in his city, this pension fund would not be the best choice, but rather the one somewhere in the end of the list.

To conclude the fourth chapter, although we have the same starting information for evaluating the supplementary pension funds, but the result solely depends on the individual investors preferences concerning each chosen criterion and the risks he is willing to take. The final results of evaluation are represented in Table.

Having in mind investors needs the most suitable pension fund according to the evaluation results is MP EXTREMO III supplementary pension fund. With the total scores of 0,636 when evaluating without criterion ‘Fund size‘and 0,6413 when considering all the chosen criteria.

It can be concluded that the integrated model can be extensively applied for evaluating and selecting supplementary pension funds. In comparison with other models, this integrated model is user-friendly and effective. There are several methods for evaluating multiple attributes which could be applied to the supplier selection problem. Further research may be concentrated on the application of these methods and a comparison of the relative effectiveness of the results.

CONCLUSIONS

1. After analyzing the sources of literature, activity of supplementary pension funds can be defined as financial-economical activity that seeks to accumulate funds, by collecting money, investing and reinvesting this money into diversified investment portfolio, for investors' retirement. The management of the pension fund is transferred to a pension accumulation company that provides advantages unavailable for a single investor: more investing opportunities, diversification, better trade off of risk, knowledge of information superior to a single investor, lower average costs of investment activates.

2. Investment decision process from the individual investor's perspective is a much needed area of research. There is an important distinction - the difference between choosing the right funds for an investor and predicting which funds will have the best performance. The main problems are: first, few investors have sufficient financial knowledge to input the appropriate values for the screening variables. Second, the tools do not consider the preferences of individual investors; the tools implicitly assume that each screening variable is equally important to all investors. What is more, in the real life the process of choosing supplementary pension fund is more complicated; in addition to risk and return many other factors have to be considered. Because different investors face different constraints in their investment decisions, a pension fund that is universally optimal may be impossible to find. Investors are left to their own judgments.

3. First models for evaluation of supplementary pension funds were introduced in 1965. These were simple models including simple criteria (fund size, returns, volatility of returns, and timing of investment decision) but they did not have the system of relative weights or how to know which one is more important. Later on many ways of valuation were introduced, such as: comparisons to benchmarks, risk and value relationships (Sharpe, Treynor and ect.), CAMP based measures, combined measures used to evaluate mutual funds. But there still is no unified way proposed on how to evaluate different preferences of individual investors or would be reasonably easy to use, that would allow for choice of criteria.

4. The composed AHP and GRA model has answers to the above problems. The main advantages of AHP can effectively manage tangible and intangible or qualitative and quantitative factors. One of the features of GRA is that both qualitative and quantitative

relationships can be identified among complex factors with insufficient information. The combined AHP and GRA model consists of elements from both models in order to optimize the evaluation process. It consists of four stages and some stages consist of several steps. First stage is for choosing criterion, second uses AHP to weight the evaluative criteria, third stage applies GRA to determine the weights of supplementary pension funds performance. And the fourth stage combines AHP and GRA to select the best supplementary pension fund for investor with predefined goals.

5. To accumulate the list of criteria to evaluate the supplementary pension funds, from two suggested lists, banks and mutual funds, criteria suitable for pension funds were taken. And these are the criteria: location, fund performance (these are Sharpe, Treynor, Information and Sortino ratios, also average yearly return), age of fund, size of fund, fund management fees, availability of information. Since pension funds in some ways differ from banks and mutual funds, so there is a need to introduce some additional criteria: minimal installment, up-load sum, conditions for switching funds. The evaluation model 13 criteria have been chosen and divided into three subcategories: 1) Accessibility, 2) Performance, 3) Fund descriptive parameters. Hence, the ultimate goal of evaluating the ideal supplementary pension fund can be achieved by evaluating three main indicators of pension funds.

6. In the least risky investing strategy group (investing in securities) there is only one fund, but none the less this is also the overall best performing fund Finasta obligacijų pensija plius. The total score for this fund was 0,916 when evaluating without criterion ‘fund size’ and 0,9135 when evaluating with all criteria. There are two main reasons why this particular pension fund had best results: period of existence of supplementary pension funds is long - too short to show any stable results and funds that have existed 2 years maybe trusted as much. Second, and main reason, is that period used to calculate all ratios (the last three years) have been the years of the global financial crisis that has adversely effected all investments – especially the risky ones. Thus this least risky fund had all the best conditions to survive the crises with results least intacted.

7. The second group of supplementary pension funds is the one containing the moderate risk investments or the ones using mixed investment strategy. Here the fund that outperformed all the others is MP MEDIO III supplementary pension fund with the score of 0,639 when evaluating without criterion ‘fund size’ and 0,6438 when evaluating with all criteria. If looking at the result including all evaluation criteria then DnB NORD papildoma pensija

shows almost equal performance (score of 0,6036) as this is the second largest (in asset size) supplementary pension fund and it adds to the total score.

8. The third group is taking the most risky investment decisions - it is investing mostly in company's shares. The tendency can be seen that all the supplementary pension funds belonging to this group are lining in the end of the total evaluation (when not divided in groups). This is logical as this is due to the abnormal market conditions – the financial crises – these funds have shown the worst results. But is not necessarily bad as this group is for long term investment allowing for fluctuations and in the end still being able to bring what they have promised. The best performing pension fund in this group is MP EXTREMO III. with the score of 0,636 when evaluating ithout criterion 'fund size' and 0,6413 when evaluating with all criteria. It is a clear leader leaving other pension funds behind by at least 0,1 points.

9. The chosen relative individual investor should choose to invest into MP EXTREMO III supplementary pension fund. Firstly, because this fund is the best performing fund in the group investing in shares, as this supports the investor wish of taking more risk. Secondly, this pension fund very well represents relative investors preference for supplementary pension funds performance ratios and yearly returns as under financial performance criteria this fund had all second highest results. What is more, it had the lowest management fees. The weak side of the MP EXTREMO III supplementary pension fund is that it is available only in three cities, but the relative investor was not very concerned about this criterion.

10. This study provides an evaluation criterion and evaluation framework for determining the suitable supplementary pension funds for different investors with different goals. The model suggests that supplementary pension fund management companies should not only focus on traditional financial criteria but also on their given conditions and the accessibility of their product. By applying AHP and GRA in obtaining criteria weight and synthesis values in ranking, priorities of the pension funds are these: Finasta obligacijų pensija plius; MP MEDIO III and MP EXTREMO III. For Lithuanian supplementary pension funds market in the case implementation, the proposed model might be of practical utility. The proved evaluation model and method can evaluate the optimal supplementary pension fund for individual investor.

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APPENDICES

APPENDIX A

Monthly returns of chosen indeces

	JP Morgan Global Bond index EMU	One month VILIBOR (indexed) - 50bp	MSCI Europe Index	MSCI Emerging markets	MSCI AC World Index	Bloomberg/EFFAS Bond Indices Euro Govt (1-5Yr)	Euro Cash Indices Libor Total Return 3 Months Index	Msci Eastern Europe small cap index
2007.10.11	1	5,03	110,280	135,320	109,080	138,054	4,72188	124,810
2007.11.11	1,0034	5,6	103,940	130,090	101,360	139,3590	4,5788	117,000
2007.12.11	1,0081	6,42	105,100	130,070	102,490	139,3220	4,9038	116,200
2008.01.11	1,0188	4,29	96,460	122,600	95,440	140,5450	4,5725	108,870
2008.02.11	1,0377	3,79	88,130	111,740	90,410	142,9310	4,3363	101,890
2008.03.11	1,0347	3,84	86,770	109,020	86,150	142,6870	4,5956	99,100
2008.04.11	1,0325	4,04	87,520	109,590	85,940	142,4000	4,7475	100,530
2008.05.11	1,0200	4,03	91,590	115,070	91,130	142,1050	4,8531	98,480
2008.06.11	1,0027	4,24	85,190	108,810	86,820	139,8810	4,9550	92,600
2008.07.11	1,0031	4,46	76,250	97,950	78,460	140,8720	4,9569	80,990
2008.08.11	1,0252	4,47	82,470	98,670	84,060	142,5160	4,9606	79,360
2008.09.11	1,0347	4,51	77,540	90,120	82,780	143,6040	4,9531	71,890
2008.10.11	1,0500	5,48	57,550	65,480	61,360	145,8570	5,3863	49,590
2008.11.11	1,0667	5,34	59,390	66,170	65,390	148,2740	4,3213	40,640
2008.12.11	1,0815	7,08	56,780	64,240	61,270	148,6890	3,3288	37,020
2009.01.11	1,0968	6,4	57,970	63,180	61,880	150,8890	2,6888	33,640
2009.02.11	1,0909	3,3	54,000	64,100	59,670	152,4260	1,9925	28,960
2009.03.11	1,0948	2,58	46,550	59,950	52,500	152,5250	1,6656	27,180
2009.04.11	1,1046	2,02	52,710	71,950	60,210	153,3190	1,4281	35,940
2009.05.11	1,1088	2,17	58,130	79,360	64,180	154,4600	1,2963	40,220
2009.06.11	1,0882	4,78	60,600	83,990	65,910	153,4520	1,2703	47,330
2009.07.11	1,1216	5,12	55,550	78,880	61,540	155,5830	0,9925	41,190
2009.08.11	1,1285	4,49	63,700	89,270	69,160	155,4120	0,8450	51,620
2009.09.11	1,1425	2,82	68,200	91,440	71,320	156,8950	0,7319	57,580
2009.10.11	1,1462	2,67	68,560	95,800	72,260	156,9660	0,7025	57,620
2009.11.11	1,1485	1,67	69,430	96,900	72,610	157,6270	0,6725	58,810
2009.12.11	1,1515	1,08	68,990	99,400	74,070	157,7060	0,6775	56,790
2010.01.11	1,1495	0,7	72,970	105,590	77,900	157,9340	0,6375	62,420
2010.02.11	1,1566	0,5	68,280	101,350	76,240	158,4650	0,5972	61,950
2010.03.11	1,1636	0,4	72,720	108,150	81,000	159,2400	0,5919	69,800
2010.04.11	1,1660	0,39	76,230	116,010	85,430	159,4140	0,5806	78,720
2010.05.11	1,1725	0,39	71,600	112,890	84,500	160,2880	0,6275	69,140
2010.06.11	1,1751	0,5	70,560	113,310	83,840	160,3750	0,6519	67,400
2010.07.11	1,1763	0,55	70,680	112,570	81,350	159,9150	0,7600	67,000
2010.08.11	1,1967	0,48	72,040	113,760	81,350	160,9280	0,8350	69,820
2010.09.11	1,1968	0,44	74,890	118,930	84,490	161,0460	0,8234	75,470
2010.10.11	1,2082	0,41	74,630	119,110	82,560	161,7680	0,9144	75,780
2010.11.11	1,1826	0,59	77,010	124,480	86,490	159,9780	0,9931	78,060

APPENDIX B

AHP calculations with all criteria

Top level criteria pairwise matrix

	C1	C2	C3
C1	1	1/8	1/3
C2	8	1	3
C3	3	1/3	1
Total	1	1/8	1/3

C1 sub criteria pairwise matrix

	SC11	SC12
SC11	1	2
SC12	1/2	1
Total	1,5	3

C2 sub criteria pairwise matrix

	SC21	SC22	SC23	SC24	SC25
SC21	1	2	1/2	2	1/3
SC22	1/2	1	1/3	1	1/6
SC23	2	3	1	3	1/2
SC24	1/2	1	1/3	1	1/6
SC25	3	6	2	6	1
Total	7	13	4,166667	13	2,166667

C3 sub criteria pairwise matrix

	SC31	SC32	SC33	SC34	SC35	SC36
SC31	1	0,111111	0,333333	0,2	0,5	0,142857
SC32	9	1	4	3	7	2
SC33	3	0,25	1	1	2	0,25
SC34	5	0,333333	1	1	3	0,333333
SC35	2	0,142857	0,5	0,333333	1	0,2
SC36	7	0,5	4	3	5	1
Total	27	2,337302	10,83333	8,533333	18,5	3,92619

Cont. APPENDIX B

Top level criteria eigenvector

	C1	C2	C3	Priority vector
C1	0,083333	0,085714	0,076923	0,0820
C2	0,666667	0,685714	0,692308	0,6816
C3	0,25	0,228571	0,230769	0,2364

C1 sub criteria eigenvector

	SC11	SC12	Priority vector
SC11	0,666667	0,666667	0,6667
SC12	0,333333	0,333333	0,3333

C2 sub criteria eigenvector

	SC21	SC22	SC23	SC24	SC25	Priority vector
SC21	0,142857	0,153846	0,12	0,153846	0,153846	0,1449
SC22	0,071429	0,076923	0,08	0,076923	0,076923	0,0764
SC23	0,285714	0,230769	0,24	0,230769	0,230769	0,2436
SC24	0,071429	0,076923	0,08	0,076923	0,076923	0,0764
SC25	0,428571	0,461538	0,48	0,461538	0,461538	0,4586

C3 sub criteria eigenvector

	SC31	SC32	SC33	SC34	SC35	SC36	Priority vector
SC31	0,037037	0,047538	0,030769	0,023438	0,027027	0,036386	0,0337
SC32	0,333333	0,427844	0,369231	0,351563	0,378378	0,5094	0,3950
SC33	0,111111	0,106961	0,092308	0,117188	0,108108	0,063675	0,0999
SC34	0,185185	0,142615	0,092308	0,117188	0,162162	0,0849	0,1307
SC35	0,074074	0,061121	0,046154	0,039063	0,054054	0,05094	0,0542
SC36	0,259259	0,213922	0,369231	0,351563	0,27027	0,2547	0,2865

Cont. APPENDIX B

Consistency calculation data for all criteria and sub criteria

	Top level criteria	**C1 sub criteria**	**C2 sub criteria**	**C3 sub criteria**
RI	0,58	0	1,15	1,24
λmax	3,002432	2	5,010315	6,158852
CI	0,001216	0	0,002579	0,03177
CR	**0,002096**	**0**	**0,002302**	**0,025621**
n	3	2	5	6

APPENDIX C

Questionaire (all criteria)

I. Main criteria

Criterion	Importance									Criterion
☐ Availibility	1	2	3	4	5	6	7	8	9	Performance ☐
☐ Availibility	1	2	3	4	5	6	7	8	9	Requirements ☐
☐ Performance	1	2	3	4	5	6	7	8	9	Requirements ☐

II. Subcriteria

1. Availibility subcriteria

Criterion	Importance									Criterion
☐ Location	1	2	3	4	5	6	7	8	9	Information ☐

2. Performance subcriteria

Criterion	Importance									Criterion
☐ Sharpe	1	2	3	4	5	6	7	8	9	Treynor ☐
☐ Sharpe	1	2	3	4	5	6	7	8	9	Sortino ☐
☐ Sharpe	1	2	3	4	5	6	7	8	9	Information ratio ☐
☐ Sharpe	1	2	3	4	5	6	7	8	9	ROI ☐
☐ Treynor	1	2	3	4	5	6	7	8	9	Sortino ☐
☐ Treynor	1	2	3	4	5	6	7	8	9	Information ratio ☐
☐ Treynor	1	2	3	4	5	6	7	8	9	ROI ☐
☐ Sortino	1	2	3	4	5	6	7	8	9	Information ratio ☐
☐ Sortino	1	2	3	4	5	6	7	8	9	ROI ☐
☐Information ratio	1	2	3	4	5	6	7	8	9	ROI ☐

Cont. APPENDIX C

3. Requirements subcriteria

Criterion	Importance									Criterion
☐ Fund size	1	2	3	4	5	6	7	8	9	Management fees ☐
☐ Fund size	1	2	3	4	5	6	7	8	9	Minimal monthly installment ☐
☐ Fund size	1	2	3	4	5	6	7	8	9	Up-load sum ☐
☐ Fund size	1	2	3	4	5	6	7	8	9	Switching funds ☐
☐ Fund size	1	2	3	4	5	6	7	8	9	Funds age ☐
☐ Management fees	1	2	3	4	5	6	7	8	9	Minimal monthly installment ☐
☐ Management fees	1	2	3	4	5	6	7	8	9	Up-load sum ☐
☐ Management fees	1	2	3	4	5	6	7	8	9	Switching funds ☐
☐ Management fees	1	2	3	4	5	6	7	8	9	Funds age ☐
☐ Minimal monthly installment	1	2	3	4	5	6	7	8	9	Up-load sum ☐
☐ Minimal monthly installment	1	2	3	4	5	6	7	8	9	Switching funds ☐
☐ Minimal monthly installment	1	2	3	4	5	6	7	8	9	Funds age ☐
☐ Up-load sum	1	2	3	4	5	6	7	8	9	Switching funds ☐
☐ Up-load sum	1	2	3	4	5	6	7	8	9	Funds age ☐
☐ Switching funds	1	2	3	4	5	6	7	8	9	Funds age ☐

APPENDIX D
GRA calculations (with all criteria)

Difference series

	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC31	SC32	SC33	SC34	SC35	SC36
X1	0,341	0,200	0,495	0,681	0,664	0,465	0,335	0,700	0,730	1,000	1,000	0,050	0,000
X2	0,341	0,200	0,763	0,715	0,867	0,657	0,253	0,000	1,000	1,000	1,000	0,050	0,000
X3	0,000	0,000	0,709	0,666	0,830	0,363	0,202	0,634	0,986	1,000	0,002	1,000	0,000
X4	0,000	0,000	0,783	0,741	0,883	0,435	0,957	0,978	0,986	1,000	0,002	1,000	1,000
X5	0,854	1,000	1,000	0,867	0,994	0,304	0,454	1,000	0,000	1,000	0,002	0,000	0,000
X6	1,000	0,000	0,989	1,000	1,000	1,000	1,000	0,882	0,730	1,000	0,002	0,000	0,000
X7	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,967	0,216	1,000	0,002	0,000	0,000
X8	1,000	0,200	0,422	0,506	0,551	0,256	0,045	0,995	0,703	0,000	0,000	0,250	1,000
X9	1,000	0,200	0,407	0,453	0,534	0,252	0,057	0,972	0,703	0,000	0,000	0,250	1,000

Relational coefficients

	SC11	SC12	SC21	SC22	SC23	SC24	SC25	SC31	SC32	SC33	SC34	SC35	SC36
X1	0,594	0,714	0,503	0,423	0,430	0,518	0,599	0,417	0,407	0,333	0,333	0,909	1,000
X2	0,594	0,714	0,396	0,411	0,366	0,432	0,664	1,000	0,333	0,333	0,333	0,909	1,000
X3	1,000	1,000	0,414	0,429	0,376	0,579	0,712	0,441	0,336	0,333	0,997	0,333	1,000
X4	1,000	1,000	0,390	0,403	0,362	0,535	0,343	0,338	0,336	0,333	0,997	0,333	0,333
X5	0,369	0,333	0,333	0,366	0,335	0,622	0,524	0,333	1,000	0,333	0,997	1,000	1,000
X6	0,333	1,000	0,336	0,333	0,333	0,333	0,333	0,362	0,407	0,333	0,997	1,000	1,000
X7	0,333	1,000	1,000	1,000	1,000	1,000	1,000	0,341	0,698	0,333	0,997	1,000	1,000
X8	0,333	0,714	0,542	0,497	0,476	0,662	0,917	0,334	0,416	1,000	1,000	0,667	0,333
X9	0,333	0,714	0,551	0,525	0,484	0,665	0,897	0,340	0,416	1,000	1,000	0,667	0,333