Assessment of the Impact of Competencies for the Employment of Pre-retirement age people in Lithuania (applying the method of fuzzy logics)

1 Sandra Jakstiene, 2 Ojaras Purvinis, 3 Valdas Narbutas

1 Dr., Panevezys Faculty of Technologies and Business, Kaunas University of Technologies, Nemuno str. 33, LT-37164, Panevezys, Lithuania
2 Assoc. Prof., Panevezys Faculty of Technologies and Business, Kaunas University of Technologies, Nemuno str. 33, LT-37164, Panevezys, Lithuania
3 Lect., Panevezys Faculty of Technologies and Business, Kaunas University of Technologies, Nemuno str. 33, LT-37164, Panevezys, Lithuania

1 sandra.jakstiene@ktu.lt, 2 ojaras.purvinis@ktu.lt, 3 valdas.narbutas@ktu.lt

ABSTRACT

In analyzing the employment of population, an increasing emphasis is being put on the importance of employment and it’s affecting factors. Researchers examine various aspects of these factors on employment, i.e. distinguish its various determinants. Important factors influencing population employment become associated with those factors or with human factors, i.e. personal skills or employment qualitative factors. This paper explores the impact of competencies into the pre-retirement age people opportunities employment in Lithuania, applying the fuzzy logic approach. To tackle the problem, scientific literature analysis, expert evaluation and fuzzy logic methods are used.

Keywords: competencies, employment, pre-retirement age people, fuzzy logic.

1. INTRODUCTION

The situation with pre-retirement age people in the labour market has been long discussed in scientific research, which particularly intensified after regaining Lithuania’s independence, as this segment came across essential system changes. The European Commission in its new job creation and development strategy “Europe 2020” defines this segment as one of the most vulnerable ones in the labour market. It is important to note that the occupancy opportunities of this segment are limited, as these opportunities mainly depend not only on the changes of macro economical factors, but also on micro economical ones, directly related to the individual, i.e. such human factors as competencies and being competent or qualitative employment factors. Pre-retirement age people need special attention in dealing with their issues in the labour market. In the context of global market it is essential to take a new look at the ongoing processes and evaluate human factors as one of the most essential ones.

The assessment of qualitative employment factors for pre-retirement age people may help identify essential factors and determine their impact for the pre-retirement age people employment; also identify the problem areas in employment which are essential in formulating decisions which might in their turn increase employment opportunities for those segments.

Research in the papers of the following authors [7, 9, 11, 12, 13, 19, 26] revealed the trend that the abovementioned researchers apply different research methods and are mainly oriented towards the analysis of statistical data, which comprises different groups of countries, and periods of times; different data sources are used (the indicators of economical factors and employment data are usually derived from OECD data bases; Eurostat data are used for the analysis of the EU member states; in case of Lithuania, the data are derived from the data bases of the Department of Statistics of Lithuania). The research also demonstrated that the researchers into economical analysis rarely integrate new and innovative research methods and/or apply combinations of several research methods. The analyzed literature also tends to pay little attention to the qualitative factors in the evaluation of employment.

The research problem could be formulated presenting the following question: how could the impact of competencies be evaluated if an innovative evaluation method is used? Research object – the impact of competencies for the pre-retirement age people. Research goal – to carry out an assessment of the impact of competencies for pre-retirement age people employment opportunities applying the fuzzy logic approach. Objectives: (1) Reveal the interrelation of competencies and employment. (2) Identify the issues related to the pre-retirement age people in the labour market. (3) To emphasize the advantages of the application of the fuzzy logic approach in the assessment of the impact of qualitative factors for employment.

Carry out the assessment of the impact of competencies for the employment opportunities among the pre-retirement age people in Lithuania. Research methods: academic literature analysis, expert evaluation, fuzzy logic.

A novelty of the paper could be considered the preparation of the fuzzy logic system in order to assess the impact of qualitative employment factors for the pre-retirement age people. The fuzzy logic model enables to visually present and assess the impact of competencies and
is comprehensive and practically applicable in solving issues related to age people employment. This assessment model could be applied in analyzing the impact of different factors in different countries based on the researcher's choice.

2. COMPETENCY-EMPLOYMENT INTERACTION

Contemporary research literature on economics terms competence and competency are widely applied and quoted. Research literature distinguishes two notions “competence” and “competency” [18]. According to the researcher competence is part of competence. It is noticeable that competency defines the stage of a specific level of autonomy and responsibility within a definite qualification organization (output competences), i.e., a requirement at which complexity and qualification level the task is to be performed. The European Credit Transfer and Accumulation System treats competence as an ability to “apply knowledge in practice” [6]. The dictionary of contemporary Lithuanian defines the word competence as a cluster of related abilities, knowledge, and skills that enable a person to act effectively in a job or situation. While competency is defined as an aptitude to know or have a capacity of decision making [8].

Empirical research [1, 10, 15, 24, 27, 29] demonstrate that some of the more important factors influencing an individual's integration into labour market and increasing employment are personal competences (abilities, acquired knowledge, personal characteristics self-awareness) and personal competency which manifests itself by the application of the competences in daily professional activities.

Competences are acquired while studying and training; they are various kinds of knowledge, skills, values and attitudes. Having such competences is a necessary prerequisite to qualitatively perform a certain task [27]. A personal competency would be an ability to apply (specifically integrating and interconnecting) the acquired competences in such a manner that the task is performed (or an issue solved) in a competent way; or a qualitative application of personal abilities in the expression of practical activities [5, 10, 15, 29]. This means that a competence emphasizes personal preparedness (i.e., potential: knowledge, aptitude, personal characteristics) to perform a certain task and suitability to do so, while a competency puts emphasis on the manifestation of an employee's competences on a practical [15] and is related with professional requirements [4]. Yet, there is a common agreement that a person who has necessary knowledge, skills and attitudes (in the sense of input competencies), could be treated as competent in a certain professional activity [1, 27].

The modified iceberg model of competence [24] demonstrates that knowledge and skills are essential in defining a personal qualification, which is treated as an obvious part of qualifications approved by a formal document (e.g., diploma) [15]. However, it is necessary to note that it is not an essential level in the structure of the competence phenomenon [16]. The hidden part of the qualification is important which substantially determines the expression of competence. Competences are applied in the workplace [10], which put emphasis on the work efficiency and quality, in other words help the employee stay competent.

In summary, it is possible to state that competences are defined as a whole of knowledge, experience and skills or an expression of competences prior to entering labour market, i.e., intended for an employee to successfully enter the labour market or get employed; while competency manifests itself through the application of competences in work activities and they aim at retaining the workplace. The application of these two – employment opportunity and the opportunity to retain the workplace – define the person's employment opportunity.

3. ISSUES WITH THE PRE-RETIREMENT AGE PEOPLE IN THE LABOUR MARKET

There has been a considerable amount of research carried out in relation to the issues of pre-retirement age people in the labour market. [3]. [23] distinguish the following ones: 1) due to the widespread public opinion that the qualification level among the elderly is lower, i.e., their physiological changes prevent them from efficient work performance, compared with their younger counterparts. Therefore, naturally, efficient performance of these individuals is perceived as problematic. 2) reforms in the economy, changes in the enterprise ownership forms. 3) employers frequently demonstrate a negative attitude towards the employees over fifty, disbelief in their ability to increase their qualification and adapt to the fast-changing work conditions. 4) lack of self-confidence from the side of the elderly individuals states the fact that there is a naturally perceived problematic nature which arises from a general belief that qualification levels among the elderly age people are lower due to their physiological changes.

Well-experienced but older workforce is not desired in organizations, just the same way as young one without experience, yet having a diploma proving such qualifications. The employer is oriented towards the employee who already has necessary work skills, yet is quite young [17]; while [25] emphasizes that being older makes it more difficult to adapt to a rapidly changing society and to meet its sometimes too high requirements; they are not so receptive to innovations that could improve their quality of work. In addition, employers pay very little attention to this age category.
4. APPLICATION OF FUZZY LOGIC APPROACH IN ASSESSING THE IMPACT OF QUALITATIVE FACTORS IN EMPLOYMENT

One of the more recent research methods which could contribute to the increase of economical phenomena modeling is fuzzy logic, a branch of artificial intelligence. Fuzzy logic not only expanded bivalent logic, inserting an interval of intermediary logical meanings, but also defined membership functions and developed the notion of fuzzy sets. For instance, if we use the notions “a tall-short person”, the set of humans is divided into two parts only, however we often state that a person is not very tall, or not very short. Fuzzy logic more efficiently models human reasoning and comprehension of qualitative knowledge.

Fuzzy sets were introduced by Lofti Zadeh, a mathematician at the university of California. He suggested expanding the classical theory of sets, which sets a strict dependence of an element to a set or independence to it and excluding any intermediary options. According to [30], a meaning, in other words an element of a set, may partially belong to several sets, if the dependency to the set is described by the so called set or dependency functions, allowing the meaning of the subject to belong to several sets at the same time. As [20] state, it is especially important in social sciences, it is namely they that are characterized by uncertainty and imprecision related to real-life situation, which often described only qualitatively. For instance, natural speech is not based on binary logics, therefore at the same time social sciences as well could not be limited to the framework of binary logic.

When traditional research is applied, variables usually acquire numerical values and the factors under analysis are assessed qualitatively. An important notion of fuzzy logic is Linguistic Variables, which can deal with linguistic and qualitative information, and they are defined as variables, the meanings of which are words, phrases or sentences of a language – natural of artificial [2]. For instance, a phrase “possibility to get a job” is a linguistic variable, which may acquire the following meanings or values: “low”, “medium”, “high”. For instance, possibility to get a job is medium. The degree of the truth the given sentence may be absolutely true, absolutely false or some intermediate.

The values of linguistic variables can be presented as fuzzy sets [14] and fuzzy sets are the generalization of traditional sets. Fuzzy sets are the ones which are defined to the so called functional dependency, which acquires any real interval [0, 1] meaning. Here the dependency of the element to a set can be partial and is expressed by the number from the interval [0, 1] [21].

\[
\mu_A(x) = \begin{cases} 
1, & \text{if } x \in A, \\
0, & \text{if } x \notin A, \\
0 < \mu_A(x) < 1, & \text{if } x \text{ depends to } A \text{ partially;}
\end{cases}
\]

Here \( \mu_A(x) \) – is called membership function, \( A \) – fuzzy set.

Hence, the fuzzy logic approach could also be applied in modeling and visualizing the impact of qualitative factors for the pre-retirement age people employment opportunities. With the help of fuzzy logic and membership functions the qualitative factor can be assigned a quantitative expression; such an assessment makes it possible to graphically represent and work out wider interpretations of the results.

It is necessary to point out advantages of the method applied – fuzzy statements, called fuzzy rules, have a clear intuitive interpretation, as they are closely related to speech. When fuzzy models are used, expert knowledge even including vague statements could be applied; the application of fuzzy systems gives the researcher more freedom in interpreting the outputs of the system. Once the expert knowledge are entered into the software, the user is able to use the fuzzy system in assessing the employment factors and decision making.

There are also difficulties related to using this system – these systems have not yet been properly analyzed on the theoretical basis, testing and optimizing the system remain time consuming, there is still unclear how to find the optimal number of rules [21].

Based on the abovementioned advances and difficulties, the formulation of the fuzzy logic system building principles in modeling the impact of qualitative employment factors among pre-retirement age people could be considered as the novelty of the paper.

Fuzzy logic application makes it possible to assess qualitatively and graphically how qualitative employment factors, such as competence and competencies influences of the pre-retirement age people employment (for instance, job opportunities, possibilities to retain the workplace and employment possibilities), and to make decisions timely how to increase employment and thus take a deeper insight into the issue under analysis.

5. DESIGN OF THE EMPirical RESEARCH

The goal of the empirical research is to build a fuzzy logic model enabling the assessment of the impact of competence for the pre-retirement age people employment opportunities in Lithuania.

The data was collected in 2012 and research was carried out in 2013. Empirical research methodic is based on expert evaluation and application of fuzzy logic.

To define the impact of competence and competencies in pre-retirement age people's employment opportunities expert evaluation method is applied. An individual questionnaire method has been chosen; a team of 7 experts has been selected researchers, economists, small and medium size business representatives, heads of government institutions (individuals able to supply quality information regarding the topic under discussion) [22, 28]. The experts have been selected according to the following criteria: (1) competence (professional knowledge, work
experience, intuition); (2) high qualification in their own area of activity. The qualitative data obtained during the questionnaire stage have been systemized and the fuzzy logic system was developed.

An instrumentation for research was made, with the help of which an expert questionnaire to carry out qualitative research was set up. The instrumentation made it possible to formulate the following criteria of the research: (1) an opportunity to get employment; (2) an opportunity to keep employment; (3) an employment opportunity. Three interrelated fuzzy logic subsystems were set up to model employment.

1. A subsystem to model the factor opportunity to get employment, which is determined by personal competencies, i.e. input factors – professional knowledge and skills.

2. A subsystem to model the factor opportunity to keep employment, which is determined by personal competencies, i.e. input factors – motivation and skills.

3. A subsystem to model the factor employment opportunity, which is determined by the opportunity to get employment and opportunity to keep employment. Thus, the three subsystems make up a two-stage fuzzy system. System inputs are the inputs of the two first former ones. System output is output of the latter subsystem. Such a two stage fuzzy system enables to reduce number of the questions needed to build a knowledge base.

The scope of the effect of competences is graded as low, medium and high influence. The questions in the questionnaire were grouped into four blocks. The questions in the first block aimed at finding out the person's opportunity to get employment. The linguistic variable employment was attributed to three values: low, medium and high. The variable competence was also divided into three linguistic values. In this way the experts had to present answers, all of which had to have the following form:

\[
\text{IF} \text{ professional knowledge is low and the skills are high} \quad \text{THEN} \quad \text{the opportunity to get employment is medium}
\]

In IF part each of the two factors acquired all three possible values and the experts had to assess the corresponding values in the THEN part, so the questionnaire and the knowledge base derived from it was not complicated and only had \(3 \times 3 = 9\) IF-THEN rules of the form presented.

The questions in the second block aimed at finding out the expert’s knowledge about the opportunity to keep the work place. The linguistic variable opportunity to keep the work place was attributed to three values: low, medium and high and with the help of experts the rules of fuzzy system knowledge base were set up.

The third block statements are designed to assess the employment of the country's pre-retirement age people and set up the fuzzy system rules on how employment depends on the linguistic variables employment and keeping work place.

The statements in the fourth block are intended to clarify the expert characteristics. It contained six questions regarding the expert age, work experience, education, academic degree, specialization and work place.

The fuzzy system is also set up for another reason: the obtained qualitative employment reflecting results could be assessed quantitively. As it was mentioned before, in order to analyze qualitative employment factors while applying the fuzzy logic system it is essential to note that this method is based on the linguistic variables which may be assigned certain linguistic meanings (fuzzy sets). For instance, the element employment is a linguistic variable, which may have the following meanings: low, medium and high. Such application of linguistic variables enables to model the expert qualitative knowledge about situations, which in its turn can not be described numerically. For instance, the statement employment is low may have different degrees of truth from zero (statement is false) up to 1 (statement is completely true, as the environment is defined). The intermediary values between 0 and 1 correspond to the partial (fuzzy) truth of the statement due to the undefined environment or situation. Function defining these degrees of truth, is called membership function. It is important to note that fuzzy logic is one of the methods of artificial intelligence suitable to process the expert qualitative information presented.

In order to set up employment opportunity assessment and visualization system based on fuzzy logic, we should follow the algorithm presented in Figure 1. The algorithm consists of the following stages: (1) setting up Linguistic Variable Groups, assign to them linguistic values and set up their membership functions; (2) setting up Rules Blocks or qualitative knowledge base; (3) using the developed model.

Having performed the setup of the linguistic variable groups and qualitative knowledge bases, the fuzzy logic model is obtained; based on expert knowledge. The model enables to plot graphs representing the dependence of the output factor in any two input factors. This plot can be considered as graphical representation of the expert knowledge. Later when the model is applied, the numerical forecast of the output (getting employment – keeping employment – employment) ant it’s visualization can be obtained for any values of the input factors.
The calculations demonstrate that the value of Cronbach's alpha coefficient $\alpha = 0.950$ is close to 1, therefore it is possible to state that this is a well-designed questionnaire. The degree of expert opinion consistence is set applying Kendall's coefficient of concordance, the meaning of which $W$ varies from 0 to 1 ($0 \leq W \leq 1$). When the value of the coefficient equals 0, there is a total inconsistence of opinions; when it equals 1, there is a full consistence in opinions.

The calculations carried out with the help of ANOVA with Friedman's Test demonstrate the concordance coefficient value $W = 0.669$, which in its turn proves that expert opinions mainly coincide (correlate). Further, using on the expert responses and applying fuzzy logic formation algorithm (Figure 1) a fuzzy logic-based model was developed. It enabled to carry out the visualization of expert knowledge, model and assess the opportunities of getting employment, the opportunities of keeping employment and employment opportunities.

It is necessary to remind that the first research criterion aimed at modeling the opportunity to get employment. The dependence of the opportunity to get employment on professional knowledge and the skills visualization was obtained with the help of the fuzzy subsystem (Figure 2). Here the factors are presented in the 10-point scale (0 – low; 10 – high). The situation modeled: the dependence of the pre-employment age people's opportunity to get employment on their professional knowledge and skills, when the skills are graded as 5 (medium) and professional knowledge as 7.5 (high).

The reliability of the expert evaluation results was checked using Kendall's coefficient of concordance and; as Cronbach's alpha coefficient well as result reliability is determined by the respondent's (expert) level of professionalism, which is demonstrated by the expert indicators of competencies: practical experience, education, scientific degree, special skills and employment-related knowledge.

**Fig 1:** Algorithm of fuzzy system model formation

Due to simplicity or any other reasons, the linguistic values low, medium and high can be numbered as 1, 2 and 3. In this way, the corresponding values can be considered as ranks.

It is important to emphasize that the model opens wide opportunities for data interpretation in order to model various situations for the impact of labour market segments on employment and forecast the output variables numeric values and the graphical representation of the forecasts.

According to expert survey qualitative characteristics and with the help of the model, employment-related situations are modeled; they enable to monitor the impact of qualitative factors on the pre-retirement age people employment opportunity in Lithuania.

**6. RESULTS OF EMPIRIC SURVEY ON THE IMPACT OF COMPETENCIES ON EMPLOYMENT OPPORTUNITIES AMONG PRE-RETIREMENT AGE PEOPLE IN LITHUANIA**

The data of the research participants' demographic age showed that the majority of the participants belong to the age group of 51-60 years of age, which makes up 42.84 percent of the total of the participants. All of the respondents had higher education; 28.56 percent of the respondents had PhD; over a half of the respondents (57.12 percent) had qualifications in economics; the majority of respondents had work experience between 21 and 40 years (42.84 percent); most of the respondents' job position is related with small and medium-size business.

As the model is numerical, it also shows quantitative values; e.g. when the pre-retirement age people's skills equal 5 points (medium) out of 10 and professional knowledge is 7 points (high) out of 10, the opportunity to get employment is 5.2 points out of 10.

Consequently, the dependence of opportunity to get employment on maximal professional knowledge and medium skills demonstrates that employment opportunity is medium. Using the membership functions of linguistic variables it is possible to be more exact: employment opportunity is medium with the membership function value of 0.96.

**Fig 2:** Dependence of the opportunity to get employment on professional knowledge and skills
The situation modeled: the dependence of the pre-employment age people's opportunity to keep employment on their motivation and skills, when the skills are graded as 5 (medium) and motivation as 7.5 (high) (see Fig 3).

The model shows that when the skills are valued at 5 points (medium) out of 10, and motivation is 7.5 points (high) out of 10, the opportunity to keep employment is 5.5 points out of 10, i.e. partially medium with membership function value of 0.85 and the slightly high with the membership function value 0.15.

The third fuzzy subsystem aimed at evaluating employment opportunity, which are determined by the opportunity to get employment and opportunity to keep employment, which in their turn are determined by knowledge, motivation and skills. This means that here the modelling qualitative knowledge takes place in four-dimensional space, i.e. one output factor is employment and the number of input factors is three, that is why the modelling and visualization of all elements – input (professional knowledge, motivation and skills) and output (employment) – is only possible in the computer model.

Figure 4 presents the dependence of employment opportunities on professional knowledge, motivation and skills. The situation modeled: the dependence of pre-retirement age people's employment opportunities on professional knowledge, motivation and skills, when the skills are graded as 5 (medium), and professional knowledge and motivation are graded as 7.5 (high).

For instance, the model showed that if the individual's skills are average, while motivation and professional knowledge is 7.5 points (high) out of 10, the employment opportunity is at 4.8 points out of 10. According to the membership functions such an employment opportunity is partially low with the membership function value 0.12 and average with the membership function value 0.88. Thus, the employment opportunity should be considered as almost average.

Figure 5 presents summarizing data that were obtained during expert assessment and processed with the help of fuzzy logic showing the employment opportunities among pre-retirement age people; the data which determines the trends of opportunities to get employment and keep it.

The data shows that even professional knowledge and motivation increases to the maximum (i.e. 7.5 points out of 10), the employment opportunity during the period analyzed remains only average (4.8 points out of 10-point scale).

7. CONCLUSION
Having performed the impact of competences in the assessment of employment opportunities, the following research conclusions were formulated.

1. Competences emphasize the individual's preparedness to perform a certain activity and his/her suitability to do this; while competency puts emphasis on the expression of the employee's competences in practical activities. Therefore a conclusion is drawn that both competences and competency generally determine the person's employment opportunity.

2. It was also found out that the reasons for the vulnerability of pre-retirement age people are lower investment into specific human capital and its devaluation, as well as lack of self-confidence. It is possible to state that lack of basic skills, lack of life-long learning possibilities and discrimination puts obstacles on their full-fledged participation in the labour market.

3. The application of fuzzy logic model of the impact of competences and competency in assessing employment opportunities demonstrates that integration of intelligent IT (fuzzy logic) into economic research makes it possible to model and quantitatively assess otherwise hard to measure such factors (e.g. competences and
competency), and their impact on various labour market trends (e.g. among pre-retirement age people).

4. Expert assessment results showed that employment opportunity in Lithuania is only medium (4.8 points of 10-point scale), even if competences are high. Expert qualitative knowledge and the analysis of fuzzy logic model data shows the trend that competences (professional knowledge and skills) and competency (motivation and skills) makes only average impact on the employment opportunity among pre-retirement age people in the period analyzed. However, it is assumed that while economic conditions in the country are changing, this employment opportunities for this segment should change to a positive direction.

REFERENCES


AUTHOR PROFILES

Jakšiūnienė Sandra received the degree in social sciences (Economics) from 19 April, in 2013 at Kaunas University of Technology. Doctoral dissertation thesis “Assessment of Microeconomic and Macroeconomic Factors Impact on Vulnerable Labour Market Segments”. Areas of scientific interests: human resources, labour market segmentation, labour economic, fuzzy logic.

Pūrinis Šarūnas graduated Vilnius University in 1977. He defended his dissertation in 1988 at Belorusia State University and received a degree of Candidate of mathematical and physical sciences and in 1993 received a Doctor Degree from Lithuanian Science Council. Currently, he is an Associate Professor at Kaunas University of Technology. Latest research fields include application of statistics, fuzzy logic, agent-based simulation and other econometrics methods in economic modeling.

Narbutas Valdas received the degree in English Language and Literature from Lithuanian University of Educational Sciences in 1988; Master’s in Management from Kaunas University of Technology in 2001. Currently, he is a lecturer at Kaunas University of Technologies Panevėžys Faculty of Technologies and Business.