DOI: 10.20472/IAC.2015.015.064

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COMPETENCES OF ADULT POLES - EVALUATION OF THE AGE AS A DIFFERENTIATING FACTOR

Abstract:

Skills and competences are important factors influencing the human capital resources especially in the era of the knowledge-based economy. All professional activities demand various competences. Moreover, it becomes necessary to continuously enrich knowledge and skills because of the rapidly changing environment. Possessing and developing skills turn out to be indispensable elements in the functioning of the labour market. On the other hand, Poland, as many other European countries, faces the problem of the aging society and potential lack of the qualified labour force in the future. Qualifications development is therefore extremely important from the economic point of view. This paper concerns the topic of the resources of the competences possessed by the adult Poles. The main objective of this paper is to analyze the assessment of the competences made by the respondents of the nationwide survey on the human capital in Poland. Skills from various fields are taken into account. Special attention is paid to the relationships between the age and the declared skills. One of the key questions under consideration is if there are substantial demographical determinants of the competences. The dataset used for the analyses comprises variables from various measurement scales. Chosen statistical techniques adequate for such data are applied to explore and describe the nature of the relationships. Additionally, the analyses are supported by some visualization methods appropriate for a multidimensional approach.

Keywords:

adults competences, ageing society, statistical analysis

JEL Classification: J24, J19

Introduction

Skills and competences play an important role in the era of the knowledge-based economy. There are greater and greater demands from the labor market for highly qualified persons ready for enriching knowledge and skills throughout their life-span. On the other hand, Poland, as many other European countries, faces the problem of the aging society and potential lack of the qualified labour force in the future. The level of the competences as well as their development are very important issues from the economic point of view. Measuring and evaluating the competences of the labour force is not a simple task. Certain information concerning the situation in Poland can be derived from a vast survey on human capital carried out yearly from 2010. The sample size of the part addressed to individual respondents in 2013 was equal to 17 600. The survey covers many topics including the self-assessment of the competences. Górniak (2013, pp. 92-95) finds three groups of competences by analyzing mean centered data. Grześkowiak (2014) shows by the means of the categorical principal components analysis that there are some interdependences among the declared skills.

This paper deals mostly with the relation age - competences but in a specific sense. The respondents are divided into three age categories according to the theory which links the age and the career development process. The associations are analyzed against this background by applying adequate statistical methods. The first principal objective of the study is to identify the relationships and to assess their strength. The second objective is to evaluate the patterns of interdependences in the distinguished age groups. Some statistical techniques focused on the analysis of the contingency tables as well as association rules algorithm are used in order to portray the relations.

1. Description of data and analytical methods

This study is based on microdata coming from a nationwide survey on human capital in Poland entitled *Bilans kapitału ludzkiego 2013.* This survey was conducted on a sample of 17 600 respondents in productive age (i.e. 18-64 for men and 18-59 for women).

Twelve general competences included in the survey are taken into consideration (abbreviations used in tables and figures are given in brackets) (PARP, 2013, pp. 18-19):

- finding and analyzing information and drawing conclusions (Information),
- service, installation and repair of technical equipment (Machines),
- performing calculations (Calculations),
- computer skills and use of the Internet (Computer),
- artistic and creative abilities (Creativity),
- physical functioning (Physical fitness),
- self-organization of work, initiative (Initiative),
- contacts with other people (Communication),
- arranging and conducting office work (Office work),

- management skills and organization of the work of others (Management),
- availability, i.e. readiness to travel frequently, flexible working hours (Availability),
- fluent use of the Polish language in speech and in writing (Language).

Respondents rated their competences in the five-point ordinal scale:

1. low level,
2. basic level,
3. medium level,
4. high level,
5. very high level.

For some analytical purposes the answers were rescaled into binary variables representing high or better level of competence versus other levels (i.e. the code 1 for high and very high level of competence, the code 0 for medium level or lower).

This paper is focused on evaluating the relationships between the self-assessment of the competences and the age. The variable age is a metric one, but for the purpose of this study it was converted into three categories. The discretization was made according to the Super's theory which combines career stages and age (Super, 1980). This approach led to identify three age categories:

- younger: 18-24 years (corresponding to the exploration phase),
- medium: 25-44 years (corresponding to the establishment phase),
- older: 45-64 years (corresponding to the maintenance phase).

This division is not completely consistent with the Super's theory which is more extensive as it takes into account persons beyond the productive age who are not represented in *Bilans kapitału ludzkiego* survey. It should be underlined that the age variable after discretization has an ordinal character.
Several analytical methods are applied to evaluate the relations between the age and the declared competences: the Sommer's d coefficient, the relative risk measure, the odds ratio indicator and the association rules.

Sommer's d coefficient is applied for the contingency tables with ordered categories when exploratory and dependent variables can be indicated (Everitt, 1992 p. 63). In this research such an asymmetric case occurs when the level of competence is treated as the dependent variable and the age category as the independent one. Sommer's d coefficient is given by the formula (Everitt, 1992, pp. 62-63):

$$d_{YX} = \frac{P - Q}{P + Q + Y_0} \tag{1}$$

where: Y - the dependent variable, X - the exploratory variable, P - number of concordant pairs of observations, Q - the number of disconcordant pairs of observations, Y_0 - the number of observations tied to the dependent variable.
The coefficient is within the limits of -1 and 1. The independence of variables is reflected in zero and absolute values close to one indicate strong association between Y and X.

The relative risk and odds ratio measures are used to depict the association in a 2x2 contingency table or in a subset of a larger table having such dimensions. A sample relative risk is the ratio of the sample success proportions p_1 and p_2 (Agresti, 2007, pp. 27-28; Simonoff, 2003, p. 204):

$$rr = \frac{p_1}{p_2} \tag{2}$$

This indicator as a relative measure can be more relevant to evaluate the discrepancies in the proportions than the absolute difference of proportions (Agresti, 2007, p. 28). Odds ratio is another descriptive indicator allowing for the comparisons of two groups. The odds of a particular event is the ratio of the probability of its success p_i to the probability its failure:

$$odds = \frac{p_i}{1 - p_i} \tag{3}$$

The odds ratio is defined as the ratio of odds of two characteristics and its value between 0 and 1 indicates a negative association while its value greater than 1 refers to a positive association (Simonoff, 2003, pp. 204-205).

The considered list of the potential competences of the Polish labour force consists of twelve elements. The relationships of the responses in various age categories are assessed by the association rules technique applied to derive interesting information from large datasets (see Zhang & Zhang, 2002). Although the most known application of the association rules method is market basket analysis there are also other fields of usage including census, insurance or medical data (Maimon & Rokach, 2005, p.307). An association rule takes notation $A \rightarrow B$ where A is called the antecedent and B is named the consequent. A and B are bound by an arrow read as "implies" but this should be considered in terms of prediction rather than in terms of causation (Bramer, 2007, p. 206). In this study an association rule is a statement like "competence A implies competence B". The task is to identify competences frequently met together. As many association rules may be found even in a relatively small database, certain measures of their interestingness are proposed, among them the most common *support* and *confidence* levels (Bramer, 2007, p. 207). The support measure is defined as the probability of joint occurrence of statements A and B and confidence is calculated as the conditional probability of B given A (Larose, 2013, pp. 187-189). In other words the support measure represents the "frequencies of occurring patterns" and the confidence measure reflects the "strength of the implication" (Zhang & Zhang, 2002, p. 26). In this study, a valid rule is a rule with the support indicator equal to 40% or higher and the confidence indicator equal to 60% or higher. The search is limited to the rules with one antecedent and one consequent only. Negative rules are not included. Various visualization methods are proposed to present the association rules. A kind of "scatterplot" on which the size of the vertex represents the relative support and the brightness of the colour refers to the relative confidence is used in this paper.

2. Relations between the age categories and the competences level

The asymmetric version of the Sommer's d coefficient given by the formula (1) is applied to evaluate the degree of association between the age of the respondents (three-point ordinal scale) and the level of competences (five-point ordinal scale). Its values are presented in Table 1.

Table 1: Measures of association between the age discretized into three categories and the self-assessment of the competences in the five-point scale

Competence	Sommer's d coefficient	Approx. p-value
Information	**-0,153**	0,000
Machines	0,000	0,985
Calculations	-0,126	0,000
Computer	**-0,426**	0,000
Creativity	**-0,156**	0,000
Physical fitness	**-0,323**	0,000
Initiative	-0,130	0,000
Communication	-0,077	0,000
Office work	-0,122	0,000
Management	-0,069	0,000
Availability	-0,087	0,000
Language	**-0,160**	0,000

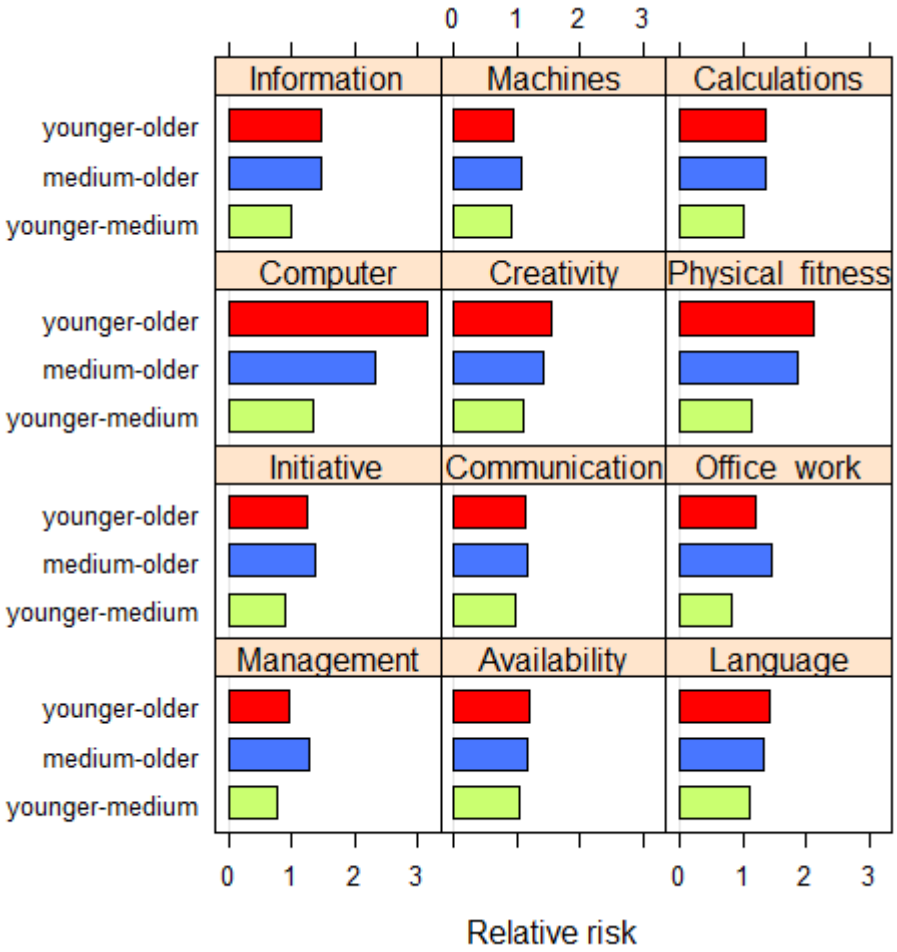
Source: own computations with PS IMAGO based on Bilans kapitału ludzkiego - 2013 data

The results in Table 1 indicate that only in one case, i.e. dealing with technical equipment , there is no significant relationship between the age and the skills level. In all other competence fields negative associations are reported pointing out that more advanced age is accompanied by the lower self-assessment of the skills. The strength of the associations varies from case to case. Although statistical significance of the relationships for eleven competences is found, some values of the Sommer's d coefficient close to zero indicate weak relationship between the variables. The strongest association is detected in case of the computer skills and the use of the Internet. Substantial negative associations are observed also for the physical functioning, the fluent use of the Polish language, the artistic and creative abilities as well as dealing with information.

Sommer's d coefficient takes into account all categories of variables, so it may be treated as a general measure. However, a more detailed insight into the relationships in the contingency table is possible, in particular the analysis of associations in 2x2 subtables by the means of the relative risk and the odds ratio indicators. The analyses presented below relate to the level of competence expressed as a binary variable (i.e. the code 1 for high and very high level of competence, the code 0 for medium level or lower).

The relative risk measures for all twelve competences across the age categories are shown in Figure 1. As there are many results to be presented, trellis graph is chosen for a concise and distinct visualization. Such comprehensive statistical graphs are accessible in R package *Lattice* (Sarkar, 2008).

Figure 1: Relative risk measures for the pairs of the age categories and the self-assessment of the competences recoded into the binary variable



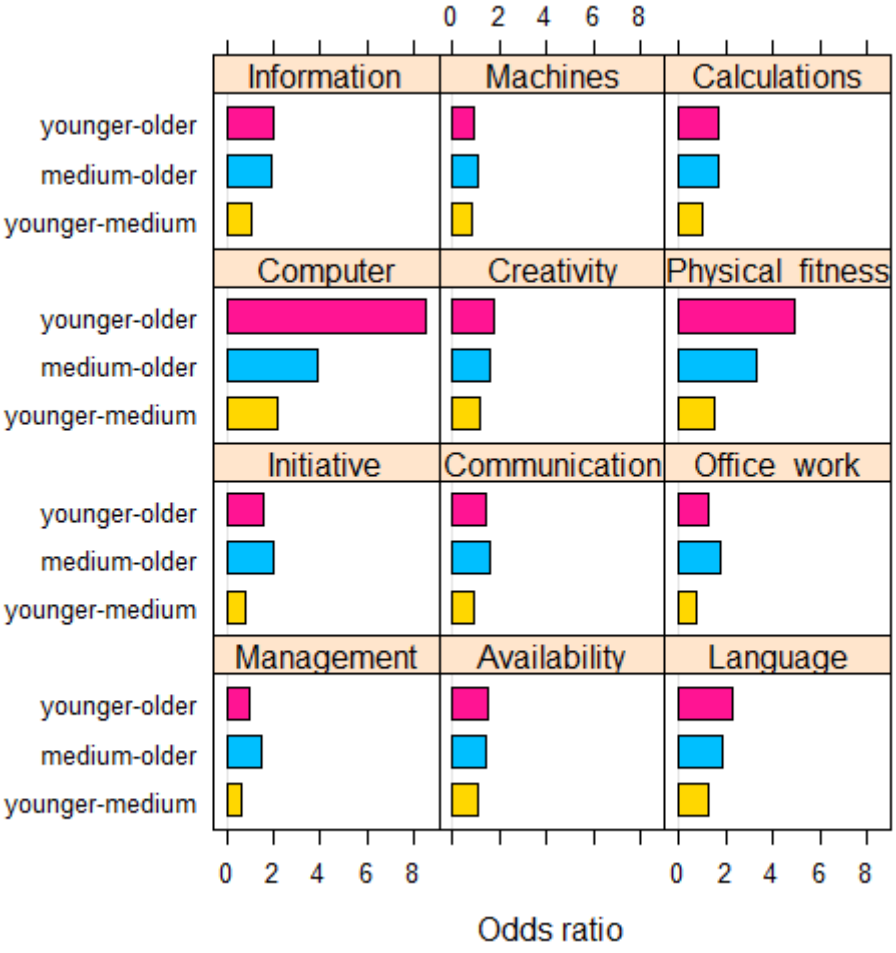
Source: own elaboration in R based on Bilans kapitału ludzkiego - 2013 data.

The general regularity is that the relative risk values are higher for comparisons with the oldest group. In most cases, the highest relative risk indicators are observed between the younger and the older group while the lowest between the younger and the medium ones. This indicates the competence gap between the persons from the oldest age category and the others. The highest relative risk occurs for the computer skills and the use of the Internet. The groups differ by a huge amount. The probability that a younger person declares a high or very high computer skills is 3,14 times bigger than for an older person. And the probability that a person from the medium age group affirms possessing such skills is 2,33 times bigger than for an older person. The relative risk is also at the remarkable level for physical fitness and creativity. An interesting pattern can be figured out for such competences as management, initiative and office work. The highest relative risk (and bigger than one) occurs when a comparison between the medium and the older age group is done. The other relative

risks concerning the youngest groups are lower than one. These results indicate that the probability of possessing such skills is the highest in the establishment phase of the career development and the lowest at the exploration stage.

The odds ratio measures for all twelve competences across the age categories are shown in Figure 2. Again, the trellis graph is used in order to present the results.

Figure 2: Odds ratio measures for the pairs of the age categories and the self-assessment of the competences recoded into the binary variable



Source: own elaboration in R based on Bilans kapitału ludzkiego - 2013 data.

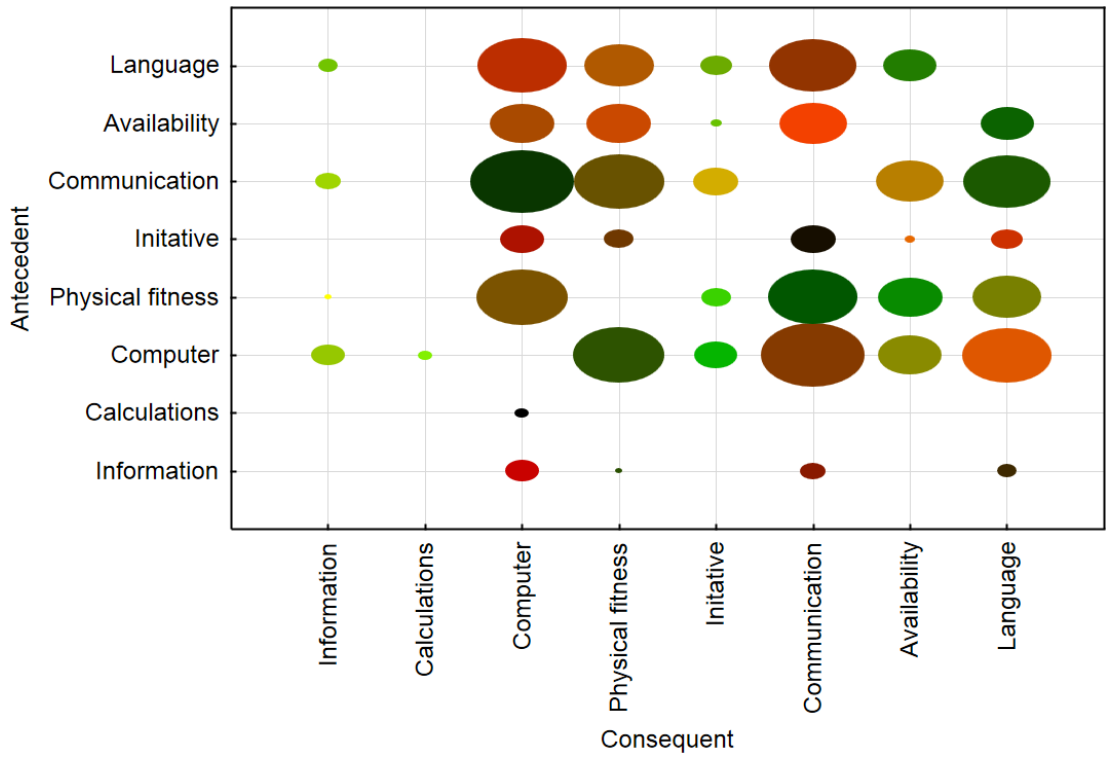
The measures shown in Figure 2 point out strong differences of odds for two competences: the computer skills and the physical fitness. Younger-older odds ratio for high and very high computer skills is equal to 8,5 indicating that the odds for a person in exploration phase are 8,5 times the odds for a person at the maintenance stage. The odds ratio for medium-older persons is also substantial as it is equal to 3,8. This gives an additional proof for the existence of the competence gap in the ICT field. The second competence characterized by very high odds ratios is the physical fitness. The odds for a younger person are almost five times the odds for an older person. The odds ratio measuring the relation between the medium age and the older age category is also considerable as it is equal to 3,3. The analysis of the odds ratios underlines a strong conditioning of computer skills and physical fitness on age.

3. Associations among the competences in the age categories

The second part of this study is dedicated to the search for relationships across the declared competences in the defined age groups. The association rules fulfilling the established criteria are presented on the graphs. The size of the vertex reflects the relative support and the brightness of the vertex represents the relative confidence of the particular association rule described by the given antecedent (Y axis) and consequent (X axis). The number of vertices gives an idea of the number of relevant rules.

Thirty eight association rules meeting the criteria were detected in the group of the youngest respondents (Figure 3). The visualization shows that there are many rules with fairly high support measure. It seems that the youngest persons have a relative high self-esteem of their competences and point out many skills together. The highest support is observed in case of communication and computer skills (57,92%), physical fitness and computer skills (55,74%), physical fitness and communication (55,43%). Interestingly, none of these pairs of competences has a very high confidence level. The highest confidence is noted for such rules as: calculations → computer skills (88,55%), finding and analyzing information → computer skills (88,21%), self-organization of work → communication with people (86,81%).

Figure 3: Association rules for the youngest group

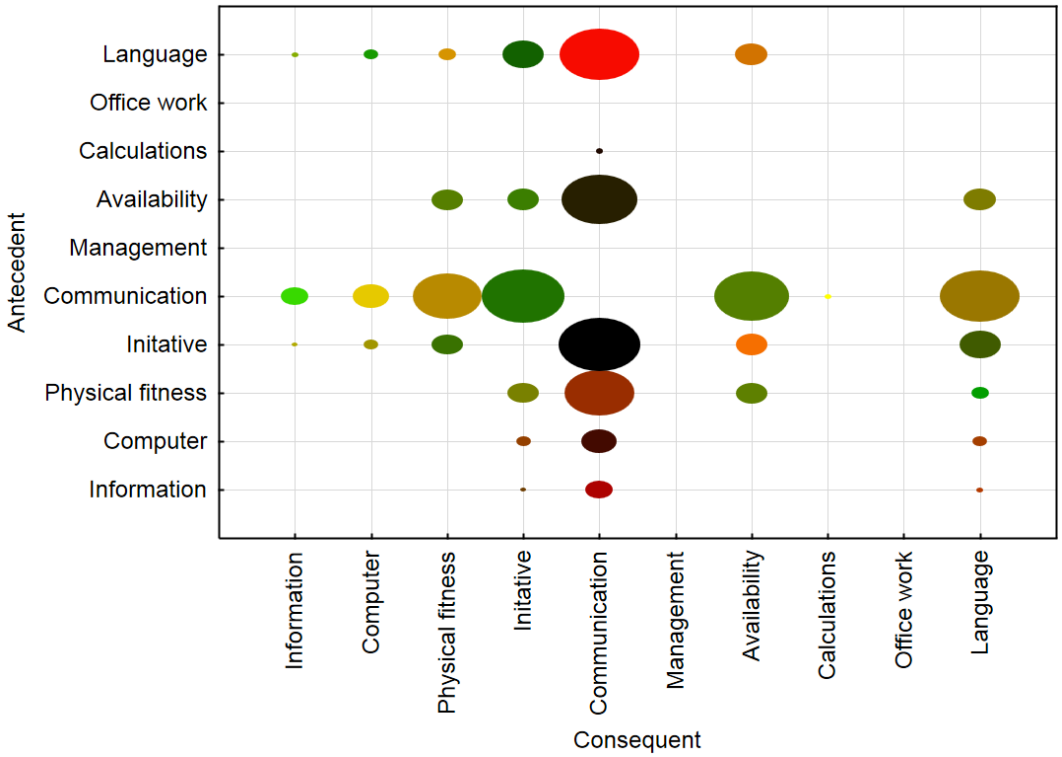


Source: own computations with Statistica based on Bilans kapitału ludzkiego - 2013 data

Fewer association rules are found in the group in the establishment phase (Figure 4). There are thirty three rules meeting the imposed criteria. The pattern of the relationships differs substantially from the one found for the youngest group. The rules with the highest support indicator concern the associations of various competences

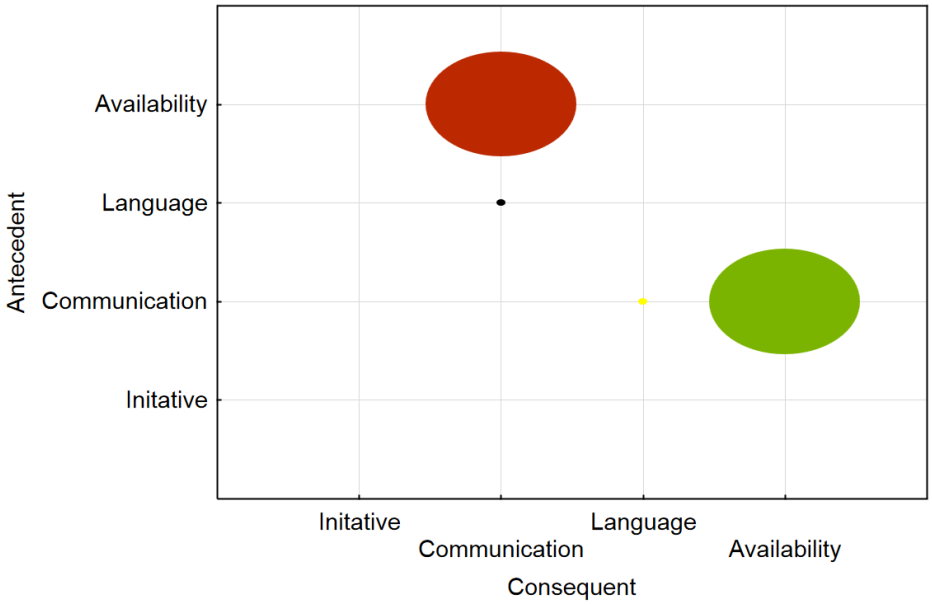
with the communication skills. Particularly high values of this measure occur in the cases of: initiative and communication (54,11%), language and communication (53,70%), availability and communication (53,00%). Moreover, all the rules with the highest confidence level contain the communication skills as the consequent: initiative → communication (88,64%), information → communication (88,30%), calculations → communication (87,50%).

Figure 4: Association rules for the medium group



Source: own computations with Statistica based on Bilans kapitału ludzkiego - 2013 data

Figure 5: Association rules for the oldest group



Source: own computations with Statistica based on Bilans kapitału ludzkiego - 2013 data

Only four association rules occur in the oldest group (Figure 5). All of them include the competence related to the contacts with other people. The support measure is equal to 44,03% in case of availability and communication and 40% in case of Polish language skills and communication. The highest confidence level is observed for the rules: language → communication (84,99%) and availability → communication (81,46%). It is worth emphasizing the occurrence of very few associations among the declared competences. This is particularly evident if a comparison with the other age groups is made, for which more than thirty association rules were identified.

Conclusions

The level of competences and the relationships between them are related to the age of the respondents. The strength of the associations varies depending on the type of the competence. The strongest relationships were found for computer skills and physical fitness. The only competence which is not related to age is the usage of the technical equipment.

According to the self-assessment done by the respondents, there are competency gaps between the oldest age group and the others. This is particularly noticeable in the ICT field.

The identified association rules show the differences in the competences patterns between the adults of different age corresponding to their professional development stage. There are many competences with a high degree of association in the phase of exploration and establishment, while only few ones in the maintenance phase.

It is worth underlying that this study is based on the subjective assessments of skills and not on the objective criteria. Hence, it shows how adult Poles evaluate their professional skills but does not provide a verification of these skills.

Acknowledgments

This research was financed by Narodowe Centrum Nauki (National Science Centre) in Poland under the project entitled "Non-metric multivariate data analysis as a tool for study of adults situation in the context of demographic changes". Project number: 2012/05/B/HS4/02499.The data on individuals are from the survey Bilans Kapitału Ludzkiego – 2013 (retrieved 2015-03-06).

References:

AGRESTI, A. (2007). *An introduction to categorical data analysis*, New York: Wiley.

BRAMER, M. (2007). *Principles of data mining*. London: Springer.

EVERITT, B. S. (1992). *The analysis of contingency tables*. New York: Springer-Science+Business Media, B.V.

GÓRNIAK, J. (2013). (Ed.). *Youth or experience? Human capital in Poland*. Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.

GRZEŚKOWIAK, A. (2014). *Deklarowane umiejętności zawodowe Polaków - analiza na podstawie danych sondażowych o charakterze niemetrycznym.* (forthcoming).

LAROSE D. T. (2013). *Odkrywanie wiedzy z danych. Wprowadzenie do eksploracji danych*. Warszawa: Wydawnictwo Naukowe PWN.

MAIMON, O. and ROKACH, L. (Eds.). (2005). *Data mining and knowledge discovery handbook.* New York: Springer.

PARP (2013). *Bilans kapitału ludzkiego w Polsce. Badania ludności*.

http://bkl.parp.gov.pl/system/files/Downloads/20140527101857/BKL_ludnosc_2013.pdf?1401179482 (retrieved 07-03-2015)

SARKAR, D. (2008). *Lattice: multivariate data visualization with R*. New York: Springer Science & Business Media.

SIMONOFF, J. S. (2003). *Analyzing categorical data*. New York: Springer Science & Business Media.

SUPER, D. E. (1980). A life-span, life-space approach to career development. *Journal of vocational behavior*, 16(3), pp. 282-298.

ZHANG, C. and ZHANG, S. (2002). *Association rule mining: models and algorithms*. Berlin - Heidelberg: Springer-Verlag.