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Preliminary communication

Managing the Human Potential of Highly Educated Experts in the Field of Technical Sciences

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Abstract: Migration of highly educated professionals has intensified worldwide in the last two decades. Attractive working conditions for highly educated specialists are subject to the human resource management policy in companies. The results of the regression analysis identified three variables of preferred working conditions in the workplace that have migration potential in the group of pull migration factors: advancement opportunities, work in the profession, and the possibility of ensuring a good quality of life. The purpose of the research was to analyse whether students in the technical field of science differ from students in other fields of science in the group of migration attraction factors. One-way ANOVA method is used for analysing differences between groups: no statistically significant differences were found in the preferences of students of technical sciences and students of other fields of science. These findings are useful to domestic companies when attracting and creating quality working conditions for technical science experts: employment in jobs in their profession, development of a career plan that includes learning and advancement, financial and nonfinancial benefits that ensure a good quality of life.

Keywords: highly educated experts; human resources management; migratory intentions; technical sciences; work condition

1 INTRODUCTION

The mobility of a highly educated workforce has been the subject of growing interest by scientists since 2000. For example, in 2000 7 papers on migration of highly educated workforce were published, and last year alone, in 2022, nearly 70 papers were published in THE SCOPUS citation database (search keywords: migration, highly skilled), brain drain: 27 works in 2000 and 167 published works in 2022. Otherwise, the term "brain drain" occurs in the 1960s and denotes the consequence of migration in which countries lose highly educated individuals who have been educated and therefore do not have the effects of investing in education [1, 2]. Attracting factors (pull factors) are key to triggering migration in the cases of a highly educated part of the working population. Foreign countries are attractive for professional reasons, and there is dissatisfaction with the general situation in their home country [3]. Companies in developed countries of the European Union, Canada, the United Kingdom and the United States are successful in attracting highly educated professionals and are particularly attractive to the labour markets of those countries, professionals educated in STEM [4]. According to a World Bank report, countries such as Croatia, Romania, Serbia, Bulgaria, and Bosnia and Herzegovina are net exporters of human capital [5].

The EuropeanUnion has recognised the importance of investing in knowledge and skills by achieving competitive advantage [22]. Highly educated people prefer permanent employment contracts, a safer and more stable work environment with opportunities for further learning on the job [23]. The average net salary is positively correlated with the newly created value in the metal processing industry. From this relationship it can be concluded that higher paid employees create a higher level of newly created value [24].

Among the main push and pull migration factors of the highly educated workforce are the unfavourable situation of the labour market (unemployment and low wages), quality of life, and working conditions [6].

Half of the current EU28 countries will have a share of the population of +25 years who have at least a postsecondary education of at least 50% by 2060, and for the Republic of Croatia the expected share is 37%, indicating a delay share of the domestic population with completed tertiary education [7].

Key migration patterns are the rate at which the migration of highly educated professionals, particularly highly skilled women whose share is increasing faster than the migration of men, is growing. A significant part of these experts targets four countries: Australia, Canada, the United Kingdom, and the United States [8].

2 LITERATURE REVIEW

Economists analyse the so-called push and pull factors of migration. Push factors include [9]: weak employment and work opportunities, low wages, poorly developed regions, lack of opportunities for advancement, and unfavourable economic situation of the family. Migration pull factors include opportunities to work in attractive jobs, higher salaries, and the possibility of financial autonomy. Similar factors are mentioned in the World Bank report [5]. People tend to migrate to countries whose economic performance is more favourable than in their country of birth and education [10].

A study of students' migratory intentions has shown that students plan migration while studying.

Santric-Milicevic et al. determine the migration intentions of medical students in the Republic of Serbia. While studying, 81% of the respondents think about migration. Some of the reasons that encourage thinking about migration are working conditions, wages, achieving a better quality of life, opportunities for advancement in the profession [11].

Plopeanu et al. investigated students' migration intentions in Romania. Tertiary education of mothers has been identified as a predictor of migration, and on the other hand, a higher level of family income negatively affects migration intentions [12].

Gherheş et al. investigate the migration intentions of Romanian mechanical engineering students. They find that around 50% of the respondents express migratory intentions while still studying. Migration is favoured by

family members who have migrated themselves, finding a job in the profession, financial compensation, career development opportunities, better technological equipment abroad, acquiring new knowledge and advancing in a professional career, and social circumstances (economic growth, political system, corruption, health system) [13].

Hemming et al. highlight youth mobility as one of the ways in which the European Union seeks to homogenise the labour market. The authors identify asymmetric patterns of migration through the term brain drain for employment. The European Union countries that employ young people are not those that educate them. Young people migrate to ensure a better living situation [14]

Van Mol explores the migration intentions of young people and observes the correlation between the level of well-being with migration aspirations, previous mobility experience in the European Union, and gender (male respondents show more migration intentions than female respondents) [15].

Bartolini et al. They explore the migration intentions of young people and identify the reasons for migration: career advancement and quality of life [16].

Okumuş explores the migration intentions of highly educated professionals: quality of life, work in the profession, and career opportunities [17].

Ciarniene and Kumpikaite investigate student attitudes on the reasons for migration and find that the economic reasons for migration are the main factor of migration in 85% of respondents [21].

The main reasons for migration in these studies are economic reasons: work conditions, generally better quality of life, opportunities for advancement, career opportunities, and further training. Migration aims to improve the personal situation and access to the European labour market.

On the basis of the research so far, a research question and hypothesis have been formulated.

Table 1 Research question and hypotheses

Research question (RQ):	Hypothesis (H):
RQ 1. Are there statistically significant differences in the variable 'Migration intentions to other countries' versus subjects according to the scientific area of study criterion?	H_0 No statistically significant differences were identified between the migratory intentions abroad of technical sciences students and students of other sciences. H_1 A statistically significant difference was identified between the migratory intentions of technical sciences students and those of other sciences students abroad.

3 RESEARCH METODOLOGY AND RESULTS

Based on Research Question 1, the research methodology was defined as follows:

- Overview of previous research results.
- Defining the research question and hypotheses.
- Creation of the pull factor migration construct.
- Creating a questionnaire with a measuring scale.
- Online distribution of questionnaires.
- Testing the internal consistency and reliability of measuring instruments and constructions [18].
- Hypothesis testing [18].
- Testing assumptions for conducting linear regression analysis [18].
- Record of research results (scientific contribution) and analysis of research results with previous research results.
- Identification of research limitations and recommendations for future research.

All variables contained in regression equations have a K-S test at $p < 0,05$. The Q-Q charts for selected variables show a normal distribution (values shown near or around a straight line). The Q-Q charts of the detrended normal data indicate a normal data distribution. The trimmed arithmetic mean in all observed variables is approximately the same as the arithmetic mean, indicating the absence of outliers. 57.6% of the subjects were women and 42.4% were men [20].

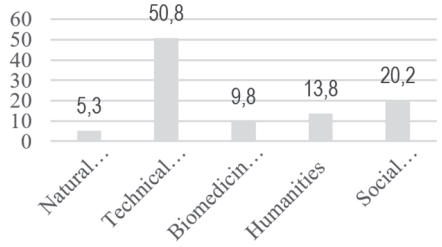

Figure 1 Structure of respondents (%) with regard to the scientific field of study

The result of Factor analysis indicates $KMO > 0.6$, Bartlett spherical test λ^2 (15) = 1486,512, $p < 0,05$ (Tab. 2).

Table 2 *KMO* and Bartlett's test

Kaiser-Meyer-Olkin (*KMO*) measure of sampling adequacy.		0,891
Bartlett's test of Sphericity	Approx. Chi-Square	1486,512
	df	15
	Sig.	0,000

Cronbachs alpha of pull factors of migration is 0,895, suggesting an excellent measurement scale of migratory intentions (Tab. 3).

Table 3 Reliability statistics

Cronbach's Alpha	*N* of the items
0,895	6

Table 4 Summary stem Statistics

	Means	Minimum	Maximum	Range	Maximum/minimum	Variance	*N* of items
Item Means	3,625	3,41	4,129	0,719	1,211	0,068	6
Inter-item Correlations	0,562	0,202	0,833	0,631	4,123	0,055	6

Table 5 Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
1	3,985	66,420	66,420	3,985	66,420	66,420

All variables belong to one factor (pull factor of migration intentions) and this factor explains 66,42% of the variance.

Descriptive statistics of independent variable "I intend to migrate (after graduation) to other countries that attract me":arithmetic mean: 2,63; 5% trimmed arithmetic mean: 2,59; variance: 1,535; standard deviation: 1,239.

Table 6 Tests of homogeneity of variances

		Levene Statistics	d*f*1	d*f*2	*Sig.*
The intention to migrate (after graduation) to other countries that attract me.	Based on on man	2,143	4	351	0,075
	Based on Median	1,568	4	351	0,182
	Based on Median and with Adjusted DF	1,568	4	346,498	0,182
	Based on he trimmed mean	2,471	4	351	0,044

Table 7 Testing of differences between groups using One-way ANOVA test

I intend to migrate (after graduation) to other countries that attract me.					
	Sum of Squares	d*f*	Mean Square	*F*	*Sig.*
Between groups	16,450	4	4,113	2,731	0,029
Within groups	528,606	351	1,506		
Total	545,056	355			

The results of the one-way ANOVA procedure ($F(4,351) = 4,113$, $p < 0,05$ identify a statistically significant difference between the groups of respondents belonging to different scientific fields of study (technical sciences, social sciences, humanities, biomedicine and health, life sciences). A post hoc analysis will determine which groups of respondents differ from those of technical sciences to migrate to other countries after graduation. Considering that the One way Anova test identified statistically significant differences between groups, a post hoc test (Hochberg) is used to determine which groups differ from each other.

Table 8 Post hoc tests

Multiple Comparisons						
Dependent variable:						
Hochberg						
(I) study		Mean difference (I-J)	STD. Error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Technical Sciences	Natural Sciences	−0,093	0,296	1,000	−0,93	0,74
	Biomedicine and Health	0,582	0,227	0,101	−0,06	1,22
	Humanities	−0,222	0,198	0,950	−0,78	0,33
	Social sciences	0,224	0,171	0,878	−0,26	0,71

The post hoc test (Hochberg) did not identify statistically significant differences between life sciences, technical sciences and biomedicine and health care intended to migrate to other countries, except in the case of biomedicine and health vs. humanities (Mean = −0.804, $p < 0,05$; CI 95% (−1,57; −0,04)). The hypothesis H_0 is accepted, no statistically significant difference has been identified between the migratory intentions abroad of technical sciences students and students of other sciences. This rejects the alternative H_1 hypothesis!

All assumptions for conducting linear regression analysis were previously tested: normality of distribution, independence of observations, absence of outliers, Levene's test of equality of variances in respondents' answers, and residual deviations in the criterion variable. On the basis of all mentioned procedures, it is concluded that the implementation of linear regression analysis is suitable for continuing the data analysis. Regression analysis will determine the contribution of individual predictors in the field of preferred working conditions to the independent criterion (dependent variable), Tab. 10.

Table 9 Leneve statistics and One-way ANOVA for pull factors of migration

Variable:	Levene Statistics	One-way ANOVA
Opportunities for advancement	$F(4,351) = 0,491$, $p > 0,05$	$F(4,351) = 7,718$, $p > 0,05$
Ensuring good quality of life	$F(4,351) = 0,363$, $p > 0,05$	$F(4,351) = 1,929$, $p > 0,05$
Finding job in the profession	$F(4,351) = 0,243$, $p > 0,05$	$F(4,351) = 1,738$, $p > 0,05$

Table 10 Regression analysis of pull migration factors

Model summary [d]									
Model	*R*	*R* Square	Adjusted *R* Square	STD. Error of the estimate	Change Statistics				
					R Square change	*F* change	d*f*1	d*f*2	Sig. *F* change
1	659 [a]	0,434	0,432	0,933	0,434	271,501	1	354	0,000
2	683 [b]	0,467	0,464	0,907	0,033	21,637	1	353	0,000
3	690 [C]	0,476	0,472	0,900	0,010	6,529	1	352	0,011
a. Predictors: (constant), Advanced opportunities									
b. Predictors: (constant), opportunities for advancement, ensuring good quality of life									
C. Predictors: (constant), opportunities for advancement, ensuring good quality of life, finding job in the profession									
D. Dependent variable: I intend to migrate (after graduation) to other countries that attract me.									

The following variables that have a statistically significant predictive capability of migration factors ($F(1,354) = 6,529$, $p = 0,011$, $R^2_{adj} = 47,2\%$) are: opportunities for advancement, ensuring good quality of

life, and finding job in the profession. In the next step, differences in the three mentioned variables will be tested between students of different scientific fields using One-way ANOVA method. Although regression analysis (forward method) identified these three variables as predictors (dependent variable: I intend to migrate after obtaining a diploma to other countries that attract me), no statistically significant differences between the respondents of technical sciences and the respondents of other sciences were identified in all three of the observed variables. Therefore, the group of respondents to technical sciences is not different from other groups of subjects in terms of variables with migratory potential. The pull factors with the potential for migration are the same for students of technical sciences and students of other science fields. The same findings are present in the research published by Santric-Milicevic et al., Gherheş et al., Bartolini et al., Okumuş, Hemming et al.

4 CONCLUSION

Developed companies from the EU, Canada, Great Britain, and the United States of America are successful in attracting highly educated specialists, and are especially attractive to specialists with STEM education. There is a situation where a highly educated individual, born and educated in one country, plans and realises his career in another country. For the country of birth and education, this represents a loss of investment in human potential, and on the other hand, it represents a gain in the human potential of the country to which a highly educated individual migrates.

The aim of the research was to determine whether there are differences between students of technical sciences and other fields of science (social sciences, humanities, natural sciences, biomedicine, and healthcare) in preferred working conditions that have migration potential. Regression analysis identified three variables of desirable working conditions at work that have migration potential in the group of pull migration factors: opportunities for advancement, work in the profession, and the possibility of ensuring a good quality of life. No statistically significant differences were found in the preferences of students in technical sciences and students in other sciences. Hypotese H_1 has been rejected. Therefore, it can be concluded that the sample of respondents is very homogeneous in their attitudes and reasons for migrating to other countries and that there are no significant differences between scientific fields in terms of the working conditions they prefer. These findings confirm the results of previous research on the reasons for the migration of highly educated professionals. These findings should also be taken into account by companies that employ a highly educated workforce in their human resource management strategies and policies. This knowledge is useful for companies in attracting and creating quality working conditions for highly qualified specialists: employment in workplaces in the profession for which they were educated, creation of a career plan that includes learning and advancement at work, financial and nonfinancial benefits that ensure a good quality of life.

The demand for highly educated specialists, especially in STEM and ICT, is increasing and most vacant positions are related to these fields. Therefore, based on the results of the research, companies are recommended to invest significant efforts to strengthen employment marketing and human resources management tools for employee retention.

A limitation of the research is that it examines the attitudes of the respondents. Patterns of migration intentions are subject to different influences, although previous research shows the same reasons for migrations of highly educated people. In future studies of migration intentions of highly educated people, the findings of previous research should be tested (include variables: career opportunities, quality of life and work in the profession). It should also be determined whether other variables have migratory potential, especially variables in the fields of politics, culture, demographics, climate change, and war conflicts. It would be necessary to conduct a geographically broader survey and cover more countries, especially the EU 15 countries and other European Union countries.

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