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Workforce Ageing and Labour Productivity Dynamics

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ORIGINAL SCIENTIFIC PAPER

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Abstract

This paper adopts a neoclassical framework to study the effect of age composition of the working-age population on labour productivity and its determinants, based on an unbalanced panel of 64 non-oil-producing countries, over the period 1950-2017. Our first contribution comes from testing whether a shock in age structure has the ability to permanently shift labour productivity dynamics. From methodological standpoint, we try to reduce the risk of model mispecification in the existing literature, that has often overlooked the possibility of cross-sectional dependence in the data and heterogeneity in slope coefficients. We also note the importance of time series properties of the data for valid statistical inference. Our results indicate, that ageing of the working-age population depresses labour productivity growth; negative impact of individuals aged between 55 and 64 on total factor productivity growth is only partially offset by its positive impact on human and physical capital accumulation. For sustaining the current level of living standards, adoption of policies, which forestall the negative impact of older workers on innovation process and promote their positive impact on the supply of production factors, is of crucial importance. We do not find evidence, that higher public spending on education in% of GDP has such an effect.

Keywords: labour productivity, demographics, neoclassical production function, panel data

Introduction

This paper adopts neoclassical framework to study the effect of age composition of the working age population on labour productivity and its determinants, based on a sample of 64 non-oil-producing countries, for the period between 1950 and 2017. Recent empirical work (Ayiar et al., 2016; Freyer, 2007) has focused on examining the effect of workforce age structure on either level or growth rate of labour productivity. To the best of our knowledge, no study has inspected the dynamic impact of the age structure on labour productivity dynamics. Our first contribution comes from testing whether a shock in age structure shifts labour productivity growth permanently or temporarily. From a methodological standpoint, we try to reduce the risk of model mispecification in the existing literature that has often overlooked the possibility of cross-sectional dependence in the data and heterogeneity in slope coefficients. We also note the importance of time series properties of the data for valid statistical inference and therefore carried out stationarity and cointegration tests. Our results indicate that a growing share of individuals in the working-age population between ages 55 and 64 depresses labour productivity growth;

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thenegative impact of older workers on total factor productivity growth is only partially offset by their positive effect on the speed of accumulation of production factors. Younger individuals, especially those between 25 and 34, seem to be the driving force of innovation and have the most positive effect on labour productivity growth.

In recent decades, advanced economies have experienced slowdown in per capita output growth. Some macroeconomic literature has associated this phenomenon with deficiencies on the demand side, resulting in a persistent output gap (Hansen, 1938). Gordon (2014), on the other hand, considers the long-term slowdown to be mainly a supply-side problem, with demographic change being one of the main »headwinds«; productivity growth may be impaired due to a reduced labour supply and future opportunities for technological innovations. Global labour productivity growth has dropped from an average annual rate of 2.9% between 2000-2007 to 2.3% between 2010-2017 (The Conference Board, 2019). Fertility rates have been declining through twentieth century, with the post WWII baby boom period as an exception, and life expectancy increased considerably in the 1990s and 2000s. Consequently, a natural increase in population has declined and the median age of global population increased from 24 to 30 between 1990 and 2015. The reduced size of the more recent generations and ageing of the baby-boom generation implies a larger share of older individuals in the workforce and a growing number of dependents in the future. Without behavioral adjustments of economic subjects to structural changes which would stimulate aggregate demand or supply, the already impaired output per capita growth may continue to decline. In this paper we focus on the effect of workforce ageing on aggregate supply. The paper is structured as follows: Section 2 discusses implications of the neoclassical and endogenous growth paradigm on interaction between demographic structure and output dynamics and reviews empirical work. Section 3 presents estimation framework and data. In Section 4, we discuss our results, from which we draw policy implications in Section 5. Section 6 concludes.

Theoretical Background and Literature Review

Aggregate labour productivity in country i in year t $\left(\frac{Y_{it}}{L_{it}}\right)$ depends on physical capital intensity $\left(\frac{K_{it}}{L_{it}}\right)$, human capital per unit of labour $\left(\frac{H_{it}}{L_{it}}\right)$ and the level of technology A (Mankiw Romer And Weil, 1992),

$$\frac{Y_{it}}{L_{it}} = \left(\frac{K_{it}}{L_{it}}\right)^{\alpha} \left(\frac{H_{it}}{L_{it}}\right)^{\beta} A^{1-\alpha-\beta}; \quad 0 < \alpha; 0 < \beta; \alpha + \beta < 1. \quad (1)$$

Labour productivity growth (g_y) is the sum of growth rates of physical capital intensity (g_k), human capital per unit of labour (g_h) and total factor productivity (g_A),

$$g_y = \alpha g_k + \beta g_h + (1 - \alpha - \beta) g_A . \quad (2)$$

The neoclassical framework postulates that short-term labour productivity growth depends largely on savings rate and human capital accumulation, provided their increase results in the net increase of aggregate savings, level of education, and experience within an economy. Long-term growth, however, is due to decreasing marginal returns of production factors, determined exogenously by technical progress. Under endogenous growth paradigm, increase in supply of production factors permanently shifts growth. Knowledge externalities from production process (Romer, 1986) and human capital accumulation (Lucas, 1988) may eliminate decreasing returns on capital at aggregate level. Productive government spending on research and development (R&D), generated by additional output, may foster innovation and thus ensure continued growth in total factor productivity (Romer, 1990).

Neoclassical and endogenous growth models assume representative agents and thus a constant age distribution. Under this assumption, age composition only affects the level of labour productivity. Countries with more favourable demographic structure may have a higher output per unit of labour. Changing the relative sizes of different age groups, however, implies a growth effect. Age structure is correlated with a permanent shift in labour productivity growth if it impacts total factor productivity growth and if growth is endogenous to output dynamics via its effect on the supply of production factors. The first aim of this paper is to determine whether age structure affects labour productivity growth or level.

We also aim to identify the channels through which age structure operates. Age structure may be correlated with labour productivity dynamics due to age-related saving and investment decisions, determining the supply of physical and human capital. Younger households have a lower propensity to save than middle-aged ones, on average. Individuals' wealth peaks just before retirement (Modigliani, 1966), implying that an increasing proportion of middle- and old-aged workers encourages national savings. In response to longer life expectancy and weakened pension systems, older workers may also decide to increase their savings to remain consumption possibilities in retirement (Mason, 2005). Falling fertility rates and the subsequent reduced burden of childrearing may hamper household consumption and contribute to an increase in savings at the aggregate. Given that international capital markets are imperfect (meaning national savings roughly equate national

investment), a larger share of older individuals in the workforce may be positively correlated with physical capital formation. Additionally, consumption smoothing and perceived higher budget constraint in the future may encourage active population to increase labour supply on intensive and extensive margin, raising the return on investment, which may in turn push down the real interest rate and foster investment activity. Age structure may as well be correlated with the accumulation of human capital, which according to Mankiw Romer and Weil (1992) largely comes from schooling. Increased life expectancy and thus longer working period increases the return on education (Ben-Porath, 1967). Ageing of the workforce may therefore increase the number of years spent in education, provided young individuals have the ability to invest in it. Behrman et al. (1999) find a positive correlation between life expectancy, school enrolment rates and human capital. Moreover, Ahlorth et al. (1997) link the peak in labour income around the age of 50 with a peak of per capita human capital supply at that age. On the other hand, Dixon (2003) associates ageing with a rise in the incidence of poor health and disability within the workforce.

Age composition may also interact with the evolution of total factor productivity. Cooley and Henricksen (2018) find that individuals' internal productivity describes an inverted U-shape over the life cycle and peaks at the age of 40. Lehman (1953) points out that researchers' innovative activity rises steeply in their 20s and 30s and peaks in the late 30s or early 40s. Acemoglu and Restrepo (2017) find a positive relationship between older populations and production automatization. Ackum-Agell (1994) also suggests that people in their 50s work more intensively than younger workers. Older workers may also be more productive thanks to their accumulated experience.

Technological absorption is also affected by age structure. A highly educated young population is believed to be the driver of absorption process, while the mature segment of the population drives technological diffusion. Studies based on microeconomic data suggest a positive correlation between a young workforce and growing enterprises, whereas stagnant firms tend to have older workforces (Prskawetz et al., 2007). Age structure is also found to be correlated with the adoption of reforms in labour and product markets. Structural reforms, which raise productivity, are generally supported by younger generations and opposed by older ones (Favero & Galasso, 2015).

A large proportion of empirical work studying the interaction between demographic structure and output dynamics has focused on the effect of the growing number of dependents in population on per capita growth (Prskawetz et al., 2007). The emphasis was thus on the effect of age composition on the supply of labour and capital dillution. Recent studies have shifted the attention to changing internal age composition of the workforce population, as dependency ratios have been commonly found insignificant in growth regressions (Prskawetz et al., 2007). Aiyar et al. (2016) link a higher share of workers aged 56-64 with lower labour productivity growth. Freyer (2007) attributes different demographic structures to almost one-quarter of the persistent productivity gap between the OECD and low-income nations and highlights the positive effect of the 40-49-year-old age group on the level of aggregate productivity. Aiyar et al. (2016) and Freyer (2007) all emphasize the importance of total factor productivity channel, through which an increasing share of older workers negatively impacts labour productivity. We try to improve upon this body of literature in several ways. First, we impose less restrictions in modelling cross-country labour productivity dynamics and its response to age structure shocks. Second, we closely examine time and cross-sectional properties of the data. Third, we do not restrict the effect of age composition to the workforce alone, but rather draw from the entire working-age population. We also limit high correlation between explanatory variables by including larger age groups than Freyer (2007) and Ayiar et al. (2016), while still controlling for the entire age distribution.

Methodology

Estimation

Labour productivity in a country i at time t, y_{it}, is assumed to follow AR(1) process and to be a function of a time invariant country fixed effects, capturing factors such as institutional quality, openness of the economy, and flexibility of the labor markets (Bloom et al., 2003), a vector of common time specific factors F_t, predominantly induced by cyclical movements and technological progress, with country specific loadings λ_i, a vector of demographic variables x_{it} and its lagged values x_{it-1} with heterogeneous slopes,

$$y_{it} = \gamma_i y_{it} + \beta_i x_{it} + \theta_i x_{it-1} + \alpha_i + \lambda_i F_t^{\,k}. \quad (3)$$

We proxy labour productivity with output per hour worked, which, in comparison to output per worker, eliminates the differences in full time/part time employment across countries and time. Our explanatory variables of interest are the proportion of young (aged 15-34), middle-aged (35-54) and old (55-64) individuals in the working-age population. Age shares sum to one. To avoid perfect multicollinearity, we exclude the 55-64 age group, because this group generally has the highest coefficient in regressions of human and physical capital when included. The coefficient on a specific

age group is interpreted as the impact on labour productivity when the population share shifts from an excluded group into that particular group. Significant coefficients indicate they are significantly different from the implied zero coefficient on the excluded age group.

Countries are assumed to react differently to age structure shock, as country-specific features may limit the extent of labour productivity response. For instance, if national savings are positively correlated with the share of older workers, the extent to which a growing proportion of older workers also correlates with higher national capital stock, which importantly and negatively depends on the openness of the economy. A potentially positive correlation between the ageing of the population and human capital formation also depends on country-specific factors. If, in certain countries, the return on investment in education in response to longer lifespan increases relatively less than in others, a growing share of older workers will have a less positive effect on human capital formation from schooling. This may be the case in Anglo-Saxon countries, where the costs of education are higher already. Moreover, the slope coefficient may also be different in less-developed countries, where young individuals may be unable to get the funding to stay in education longer. The quality of the healthcare system, the productiveness of government spending, and the efficiency of labour and product markets may also mitigate the presumably negative effect an older population has on labour productivity.

Modelling time-specific effects with cross-section specific factor loadings is attractive, because common unobserved shocks may affect the productivity of various countries to different extents. For instance, output per hour worked may increase more in response to positive technological shock in countries closer to the technological frontier. Moreover, the response of output per hour worked to global business-cycle fluctuations may be heterogeneous in sign and magnitude. Spillover effects between neighboring or more economically integrated countries may also be larger. Omitted heterogeneous factor loadings induce cross-sectionally dependent residuals. Standard fixed effects panel data estimators become inefficient and estimated standard errors biased and inconsistent. Failure to properly capture unobserved common factors may even lead to inconsistent estimates of parameters if they are correlated with age shares (Pesaran, 2006) and to a spurious result if they are non-stationary (Everaert & Vierke, 2016).

The structure of the workforce may be endogenous to output per hour worked, as it is in addition to fertility rates and migration, which are also determined by labour participation rate. If nominal wage adapts to changes in real wage fairly quickly, and if the labour supply of certain age groups is more elastic to changes in compensation rate, there may be contemporaneous reverse causality running from labour productivity to the workforce structure. Ayiar et al. (2016) find changes in the labour-force participation rate of older workers (55-64) to be much more responsive to productivity shocks than other age groups. Han (2018) finds that young workers are more easily affected by business cycle fluctuations than prime-age workers. By using age proportions of the working-age population rather than the workforce, we avoid obtaining inconsistent estimates because of endogenous regressors. Another reason for choosing the structure of the working-age population is its capability to capture the behavioral effects of age composition on labour productivity and its components more fully. By limiting the data to only workers, we would fail to capture the effect of those productive young individuals between the ages of 15-34, who are still in school and whose contribution to productivity may be significant. A possible remaining source of endogeneity in our models is immigration. If positive shock in productivity causes certain age groups to immigrate much more than the others, age composition is endogenous. Ayiar et al. (2016), however, find that this is unlikely to be the case.

Labour productivity level follows a unit root process (Table 2, row 3). Autoregressive coefficient γ_i, from equation 3, is thus equal to unity. Our least restrictive model in equation 4 is estimated with Pesaran's (2006) common correlated effects mean group estimator (CCEMG),

$$\Delta y_{it} = \beta_i x_{it} + \theta_i x_{it-1} + \alpha_i + \lambda_i F_t^{\,k} . \quad (4)$$

is unobserved and proxied by averaging the equation 4 by cross-sections. Substituting it back to the equation 4 gives the regression in equation 5, from which parameters are estimated cross-section by cross-section with OLS. Panel coefficients are averages of individual CCE estimators,

$$y_{it} = \alpha_i^{+} + \lambda_{ki}\overline{y_t} + \overline{x'_{it}}\lambda_{ki} + x'_{it}\beta_i + \varepsilon_{it}^{+} . \quad (5)$$

CCEMG allows for individual specific errors to be serially correlated, heteroskedastic and cross-sectionally dependent. To get consistent estimates, regressors need to be exogenous (Kapetanois et al. 2011). Even though the heterogenous formulation seems to be more realistic, it generally lacks any explanatory power. Provided the panel is homogeneous, efficiency gain may be achieved by pooling observations. Thus, we also estimate the model with Pesaran's (2006) common correlated effects pooled estimator (CCEP),

$$\Delta y_{it} = \beta x_{it} + \theta x_{it-1} + \alpha_i + \lambda_i F_t^{\,k} . \quad (6)$$

Tranformations on data of CCEP may not leave enough variation in the panel. We therefore restrict the model to common time fixed effect and estimate the regression in equation 7 with two ways fixed effects estimator (2WFE),

$$\Delta y_{it} = \beta x_{it} + \theta x_{it-1} + \alpha_i + F_t. \quad (7)$$

Least squares estimation is applied after within cross-section and within time variation are substracted from overall variation,

$$(\Delta y_{it} - \overline{\Delta y_i} - \overline{\Delta y_t} + \overline{\Delta y_{it}}) = \beta(x_{it} - \overline{x_i} - \overline{x_t} + \overline{x_{it}}) + \\ + \theta(x_{it-1} - \overline{x_i} - \overline{x_t} + \overline{x_{it-1}}). \quad (8)$$

Estimated coefficients express how one country's output per hour worked and age share, relative to itself, compares to another country's output per hour worked and age share relative to itself (Kropko and Kubinec, 2018). 2WFE does not eliminate cross-sectional and time variance of the data and assumes residuals to be serially uncorrelated within and across cross-sections with homoscedastic variance. Thus, we carry out Breuch – Pagan, Breuch – Godfrey, and Pesaran's CD test and if necessary report Driscoll and Kraay's (1998) standard errors, which are robust to all forms of non-spherical residuals. If the heterogeneity of slope coefficients is omitted, the pattern will remain in residuals and 2WFE will produce biased estimates. If the source of the pattern is correlated with age shares evolution, estimates will be inconsistent. We therefore relax the assumptions of $\beta_i = \beta$, $\theta_i = \theta$ and also estimate our model with mean group estimator (MG) of Pesaran and Smith (1995), which fits the model cross-section by cross-section and computes panel coefficient as an average of country specific ones. We include trend component,

$$\Delta y_{it} = \beta_i x_{it} + \theta_i x_{it-1} + \alpha_i + F_t. \quad (9)$$

The goal of the above presented estimation framework is to choose the most appropriate method for modelling labour productivity dynamics across countries. Moreover, we are interested in whether changing age composition has an impact on labour productivity growth, as noted in Ayiar et al. (2016) or level, as proposed by Freyer (2007). Econometrically speaking we are testing whether coefficient is statistically significantly different from 0 (implying growth effect) or whether $\beta = -\theta$ (implying level effect).

We also explore the channels through which age structure operates. Labour productivity $\left(\frac{Y}{H}\right)$ is assumed to be a function of physical capital per hour worked $\left(\frac{K}{H}\right)$, total factor productivity (*TFP*) and human capital from schooling per hour worked $\left(\frac{HC}{H}\right)$,

$$\frac{Y}{H}_{it} = \left(\frac{K}{H}\right)^{\alpha}_{it} \left(TFP_{it} \left(\frac{HC}{H}\right)_{it}\right)^{1-\alpha}. \quad (10)$$

Alpha is set to one third. The steady-state level of capital is an increasing function of the total factor productivity level, whereas the capital-output ratio is not; thus, we express labour productivity as a function of capital-output ratio,

$$\frac{Y}{H}_{it} = \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}}_{it} TFP_{it} \left(\frac{HC}{H}\right)_{it}. \quad (11)$$

Human capital production function is assumed to be of Mincer form,

$$\frac{HC}{H}_{it} = e^{\phi(s_{it})}. \quad (12)$$

where s_{it} is the average years of schooling and $\phi(s_{it})$ is an increasing function piecewise linear with decreasing returns to scale.

We take the natural logarithms of equation 10. TFP is defined as output per bundle of production factors,

$$\ln TFP_{it} = \ln\left(\frac{Y}{H}_{it}\right) - \frac{\alpha}{1-\alpha} \ln\left(\frac{K}{Y}\right)_{it} - \ln\left(\frac{HC}{H}_{it}\right). \quad (13)$$

We estimate auxiliary regressions, in which $\ln TFP_{it}$, $\frac{\alpha}{1-\alpha} \ln\left(\frac{K}{Y}\right)_{it}$, $\ln\left(\frac{HC}{H}_{it}\right)$ are taken as a dependent variable. This produces a set of coefficients that sum to the coefficients in labour productivity models. The relative magnitude of the coefficients indicates the importance of each channel for determining the impact of age composition on labour productivity.

Data

Our primary sample is an unbalanced panel of 64 non-oil-exporting countries for the period between 1950 and 2017. Data for calculation of age shares are taken from the United Nation's World Population Prospects database. Data for human capital index, average annual hours worked by persons engaged, real GDP, and real capital stock at constant 2011 dollar prices are taken from the Penn World table (PWT) 9.1.

Global cyclical movements may induce cross-sectional dependece of first differences of the logarithm of labour productivity (in Table 1 noted as ΔlnY/H), physical capital per hour worked (ΔlnK/Y (α/1-α)), and the residual of production function (ΔlnTFP). Time series of differenced logarithm of human capital per hour worked (ΔlnHCH/H) may be less correlated across cross-sections, as common factors driving the increasing

trend of years spent in education may be eliminated. We also expect the age proportion of individuals aged 15-34 (A1) and 35-54 (A2) to be highly correlated due to common drivers of ageing population, such as global improvement in access to healthcare and greater inclusion of women in the workforce. Pesaran's CD test (2004) detects cross-sectional dependence amongst all variables. CD statistics is under the null hypothesis of weak cross-sectional independence normally distributed and boils down to verifying whether the sum of pairwise cross-sectional correlation coefficients is statistically significantly different from zero. For unbalanced panel the statistics is calculated for the common sample as following,

$$CD = \sqrt{\frac{2}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\sqrt{T_{ij}}\widehat{\rho_{ij}}\right), \quad (14)$$

where $\left(\frac{2}{N(N-1)}\right)\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{\rho_{ij}}$ is average cross-sectional coefficient $\bar{\hat{\rho}}$ reported in Table 1 along with absolute coefficient $|\bar{\hat{\rho}}|$.

Table 1. Pesaran's CD test

Variable	CD-test statistics	p-value	$\bar{\hat{\rho}}$	$\lvert\bar{\hat{\rho}}\rvert$
ΔlnY/H	45.44	0.000	0.165	0.237
ΔlnHCH/H	17.41	0.000	0.059	0.175
ΔlnK/Y (α/1-α)	47.06	0.000	0.160	0.234
ΔlnTFP	42.96	0.000	0.152	0.236
A1	245.70	0.000	0.643	0.680
A2	172.91	0.000	0.453	0.540

Cross-sectional dependence detected in data supports choice of using CCE type estimators and also has an implication for stationarity testing. For valid standard inference, variables need to be stationary or cointegrated. First-generation panel unit root tests tend to over-reject the null hypothesis of a unit root in the presence cross-sectional dependence, if the panel serie consists of common and cross-section specific component, of which one is strongly stationary (Bai and Ng, 2004). Thus, we employ Bai and Ng's (2004) panel analysis of non-stationarity in idiosynchratic and common components (PANIC). PANIC assumes panel variable (X_{it}) to be a sum of deterministic component (D_{it}), common component $\lambda_i F_t^k$ and a laregly idiosynchratic error e_{it},

$$X_{it} = D_{it} + \lambda_i{}^k F_t{}^k + e_{it}. \quad (15)$$

F_t^k is a $k \times 1$ vector of common factors and λ_i^k a vector of factor loadings. D_{it} can be $c_i + \beta_i t$ or intercept only. F_t^k and e_{it} are unobserved and estimated on the first difference model by method of principal components. An augmented Dickey and Fuller (1979) test is carried out on e_t for each cross-sectional unit. P-values of respective tests reported in table 2 are combined by Fisher method to test the null hypothesis of a unit root, which has a Chi Squared distribution with 2N degrees of freedom. The test requires us to first establish the number of common factors needed to represent the cross-sectional dependence in data. More factors better fit the factor model at the expense of efficiency loss, as more factor loadings have to be estimated. We follow selection procedure proposed by Bai and Ng (2002), who suggest to use information criterion »BIC3« and set the maximum number of common factors to 6. In the case of a single estimated factor, Bai and Ng recommend ADF for testing the presence of a unit root. Test statistics are reported in Table 2 and compared to ADF critical values with constant. If several factors are estimated, ADF tends to overstatimate the number of common trends.

PANIC shows that series of age shares in levels are non-stationary due to more common stochastic trends. The unit root in the natural logarithm of output per hour worked cannot be rejected due to non-stationary idiosynchratic and common

Table 2. PANIC test

Variable	Pooled ADF on $\hat{e}_{it}$	ADF on $\widehat{F_t^k}$					
		k1	k2	K3	k4	k5	k6
A1	531.417**	-1.574	-3.303	-1.655	-1.831	-1.922	1.342
A2	395.339**	-3.864**	-3.193*	-3.552**	0.060	-3.083*	-1.513
lnY/H	65.376	-1.610	/	/	/	/	/
ΔlnY/H	283.082**	/	/	/	/	/	/
ΔlnHC/H	272.475**	/	/	/	/	/	/
ΔlnKY α/(1- α)	295.657**	/	/	/	/	/	/
ΔlnTFP	302.282**	-1.731	/	/	/	/	/

Notes: / indicates there are 0 estimated common components. ** indicates that the unit root is rejected at 1% level. ADF critical values for no deterministic terms (for N=25) is for 1% significance level -2.661; for 5% -1.955 and for 10% -1.609. Critical values for ADF with intercept (for N=25) is at 1% level -3.724; at 5% -2.986 and at 10% -2.633. For this test we balanced our panel for macro variables, time dimension is 23. Maximum number of lags in ADF test is set to and rounded to the nearest whole number.

component. The unit root in the growth rate of total factor productivity cannot be rejected due to one non-stationary common factor. Growth rates of output per hour worked, human capital per hour worked, and physical capital per output are stationary. Standard inference in our models is applicable if residuals are stationary.

Results

Results of the models in equations 4, 6, 7, and 9 are reported together with PANIC and Pesaran's CD tests on residuals in Table 3. Cross-sectional dependence is reduced but present in the residuals of both CCEP and CCEMG, implying cross-sectional means of explanatory and dependent variables do not fully account for dependence between units. The remaining pattern, however, seems to be stationary. Results of CCE estimators imply that the age composition of the working-age population does not have a statistically significant impact on the growth rate of labour productivity and its components. The reason for this statistical insignificance may also be the lack of variation of explanatory data after transformation, making it difficult to detect any meaningful relationship. This is especially in the case of CCEMG estimator, which estimates regression cross-section by cross-section. In 2WFE model PANIC rejects unit root in the error terms, fixed effects estimator offers meaningful results,

Table 3. Growth regressions, with contemporaneous and lagged regressors, for the sample of 64 countries, over the period 1950-2017

	Homogeneous panel				Heterogenous panel			
	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP
CCEP					CCEMG			
A1	-1.818 (5.330)	-0.237 (1.150)	0.164 (0.124)	-2.165 (4.952)	-4.571 (2.948)	**1.261‘** (0.669)	-0.580 (1.215)	**-7.375*** (3.707)
lA1	2.144 (4.752)	0.220 (1.068)	-0.323 (1.096)	2.574 (4.282)	3.547 (2.694)	-1.028 (0.744)	-0.663 (1.456)	**6.336‘** (3.586)
A2	-2.148 (4.671)	-0.279 (1.298)	-0.005 (0.153)	-2.612 (4.488)	-4.514 (2.612)	1.669 (1.232)	0.327 (1.409)	**-7.463*** (3.368)
lA2	2.319 (4.591)	0.283 (1.239)	-0.170 (1.133)	2.771 (4.148)	4.353 (2.664)	-1.483 (1.195)	-0.438 (1.379)	**6.293‘** (3.446)
$\overline{\hat{\rho}_e}$ (CD p-value)	-0.018 (0.000)	-0.011 (0.001)	-0.018 (0.000)	-0.020 (0.000)	-0.015 (0.000)	0.008 (0.015)	-0.017 (0.000)	-0.016 (0.000)
Pooled ADF on $\hat{e}_{it}$	292.463	280.801	323.781	274.357	279.069	291.501	346.265	275.759
ADF on $\hat{e}_{it}$ $(\widehat{F_t^k})$	/	/	/	/	/	/	/	/
	2WFE				MG with trend			
A1	0.194 (0.426) (0.591)	-0.317 (0.135) (0.171)	-0.338 (0.235) (0.310)	0.693 (0.597) (0.772)	0.958 (2.326)	-0.051 (0.609)	0.774 (0.677)	1.718 (0.545)
lA1	0.173 (0.426) (0.586)	0.285 (0.135) (0.172)	0.254 (0.236) (0.310)	-0.219 (0.598) (0.791)	-0.192 (2.279)	-0.068 (0.637)	-0.470 (0.649)	-1.237 (3.098)
A2	-0.153 (0.403) (0.636)	-0.301 (0.128) (0.163)	0.170 (0.226) (0.289)	-0.112 (0.565) (0.775)	0.711 (2.004)	-0.271 (0.638)	0.098 (0.675)	1.332 (2.782)
lA2	0.418 (0.403) (0.636)	0.270 (0.128) (0.172)	-0.259 (0.225) (0.305)	0.491 (0.565) (0.806)	0.503 (1.824)	0.172 (0.637)	-0.431 (0.659)	0.148 (2.589)
$\overline{\hat{\rho}_e}$ (CD p-value)	-0.020 (0.000)	-0.010 (0.005)	-0.022 (0.000)	-0.021 (0.000)	0.155 (0.000)	0.048 (0.000)	0.135 (0.000)	0.170 (0.000)
Pooled ADF on $\hat{e}_{it}$	298.357	268.906	306.595	294.989	325.543	286.523	349.415	301.319
ADF on $\hat{e}_{it}$ $(\widehat{F_t^k})$	-2.722	/	/	/	/	/	/	-3.668

Notes: All dependent variables are in natural logarithms. A1 = share of 15-34 year olds, A2 = share of 35-54 year olds, A3 = share of 55-64 year olds (excluded). lA denotes lagged shares. Standard errors in parentheses. , significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. Driscoll Kraay standard errors are in the second row below coefficients in 2WFE, maximum lag considered in autocorrelation is 4. Last two rows of each model report results from PANIC on residuals. / indicates no common trends. is average correlation coefficient between cross-country errors, reported together with CD statistics‘ p-value.

even though errors are cross-sectionally dependent (Han, 2018). Breusch–Godfrey test detects serial correlation in time dimension of residuals and Breuch-Pagan test that they have heteroskedastic variance. Provided factors inducing cross-sectional dependence of residuals are not correlated with age shares, estimated parameters are consistent but not efficient and standard error-biased. We thus adjust standard errors with Driscoll and Kraay (1998) method, which guards against all three cases of non-spherical residuals. After this adjustment, partial elasticities of age shares in all models estimated with 2WFE turn insignificant.

Insignificant results may be driven by strong collinearity between explanatory variables. Variance inflation factor (VIF) shows that a large proportion of the variance of the estimated coefficients is inflated by existence of correlation among age shares and its lagged values. VIFs for all age variables largely exceed 200. To deal with this problem, we also estimate regressions in which only the contemporaneous values of age shares are included (Table 4). VIF of explanatory variables drops to 6. Coefficients are of expected sign and their size is in all models reduced. CCEMG and CCEP again report no significant correlation between age composition and productivity growth, coefficients in CCEMG seem to be particularly biased. Estimates in the 2WFE model are significant and are also of the same sign as in CCEP model. Residuals are stationary. Coefficients in our 2WFE model represent how the shift from an excluded age group to a particular age group affects labour productivity growth, across countries, relative to its mean value. Increasing the share of individuals aged 55-64 seems to be correlated with lower labour productivity growth (Table 4). A 1 p.p. shift from age group 55-64 to 15-34 is a associated with an increase of labour productivity growth for 0.35 p.p., whereas a 1 p.p. shift from 55-64 to 35-54 age group increases labour productivity growth for 0.25 p.p. TFP channel dominates. The youngest share promotes TFP growth to the largest extent. A 1 p.p. shift from 55-64 to 15-34 age group is associated with 0.45 p.p. higher TFP growth, whereas shifting from 55-64 to 35-54 group increases TFP growth for 0.34 p.p. The negative effect of 55-64 age share on TFP growth is, to a very limited extent, offset by its positive effect on the growth rate of physical capital per output and human capital per hour worked. Moving from the 55-64 age group into the 15-34 age group is associated with a 0.037 p.p. drop in the growth rate of human capital per hour worked, whereas no

Table 4. Growth regressions, with contemporaneous regressors, for the sample of 64 countries, over the period 1950-2017

	Homogeneous panel				Heterogeneous panel			
	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP
	CCEP				CCEMG			
A1	0.190 (0.647)	-0.047 (0.078)	-0.105 (0.212)	0.328 (0.396)	-0.071 (0.986)	-0.083 (0.117)	-0.390 (0.241)	-0.390 (0.241)
A2	0.073 (0.603)	-0.049 (0.100)	-0.114 (0.176)	0.229 (0.775)	1.021 (0.747)	-0.192 (0.167)	-0.267 (0.185)	-0.267 (0.185)
$\bar{\hat{\rho}}_e$ (CD p-value)	-0.017 (0.000)	-0.012 (0.000)	-0.017 (0.000)	-0.020 (0.000)	-0.013 (0.001)	-0.011 (0.002)	-0.017 (0.000)	-0.017 (0.000)
Pooled ADF on $\hat{e}_{it}$	290.486	262.682	302.743	292.741	295.774	291.804	359.775	359.775
ADF on $\hat{e}_{it}$ $(\widehat{F}_t^k)$	/	/	/	/	/	/	/	/
	2WFE				MG with trend			
A1	**0.354***** (0.045) (0.072)	**-0.037*** **(**0.014) (0.017)	**-0.070*** **(**0.026) (0.033)	**0.451***** (0.063) (0.094)	0.498 (0.342)	0.024 (0.068)	0.255 (0.157)	0.088 (0.371)
A2	**0.253*** (0.058) (0.103)	-0.032 (0.018) (0.025)	-0.062 (0.033) (0.042)	**0.344*** (0.081) (0.134)	**1.048**** (0.402)	**-0.132*** (0.055)	**-0.310*** (0.157)	**1.463**** (0.502)
$\bar{\hat{\rho}}_e$ (CD p-value)	-0.020 (0.000)	-0.010 (0.006)	-0.022 (0.000)	-0.021 (0.000)	0.154 (0.000)	0.044 (0.000)	0.133 (0.000)	0.160 (0.000)
Pooled ADF on $\hat{e}_{it}$	300 ***	269***	304***	298***	330***	293***	334***	341***
ADF on $\hat{e}_{it}$ $(\widehat{F}_t^k)$	/	/	/	/	/	/	/	-3.211***

Notes: All dependent variables are in natural logarithms. A1 = share of 15-34 year olds, A2 = share of 35-54 year olds, A3 = share of 55-64 year olds. Standard errors in parentheses. , significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. Driscoll Kraay standard errors are in the second row below coefficients in 2WFE, maximum lag considered in autocorrelation is set to 4. Last two rows of each model report results from PANIC on residuals. / indicates no common trends. is average correlation coefficient between cross-country errors, reported together with CD statistics‘ p-value.

significant relationship is detected when moving to the 35-54 age group. Moving from the 55-64 to the 14-34 age group depresses physical capital deepening about twice as much as human capital deepening, whereas the effect of moving from the 55-64 to the 35-54 group is also insignificant.

To reduce heterogeneity of the panel, we also estimate growth regressions with 2WFE for the sample of OECD countries (Table 5). The TFP channel remains dominant, whereas human capital becomes insignificant. Error cross-sectional dependence is stronger in those models, indicating stronger spillover effects across OECD countries. For this sample we also report estimates with age proportions by 10-year age groups (Table 6). Individuals aged 55-64 are again found to be negatively correlated with labour productivity growth. Moving from this age group

Table 5. Growth regressions, with contemporaneous regressors, for the sample of OECD countries, over the period 1950-2017

	2WFE			
	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP
A1	**0.223***** (0.047)	-0.028 (0.018)	**-0.092***** (0.025)	**0.296***** (0.064)
A2	**0.121*** (0.056)	-0.016 (0.021)	-0.031 (0.029)	0.119 (0.077)
$\overline{\overline{\rho}}_e$ (CD p-value)	-0.052 (0.000)	-0.032 (0.000)	-0.065 (0.000)	-0.053 (0.000)
Pooled ADF on $\hat{e}_{it}$	177.879	143.830	144.780	162.856
ADF on $\hat{e}_{it}$ $(\widehat{F}_t^k)$	-2.680	-3.827	-1.773	-2.120

Notes: All dependent variables are in natural logarithms. A1 = share of 15-34 year olds, A2 = share of 35-54 year olds, A3 = share of 55-64 year olds (excluded). Standard errors in parentheses. , significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. Last two rows of each model report results from PANIC on residuals. is average correlation coefficient between cross-country errors, reported together with CD statistics‘ p-value.

Table 6. Growth regressions, with contemporaneous regressors, narrower definition of age shares, for the sample of OECD countries, over the period 1950-2017

	2WFE			
	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP
W0	**0.215***** (0.050) (0.050)	-0.036 (0.019) (0.023)	**-0.107*** (0.022) (0.058)	**-0.324***** (0.019) (0.077)
W1	**0.267***** (0.060) (0.073)	0.015 (0.023) (0.028)	-0.012 (0.027) (0.043)	**0.251*** (0.023) (0.114)
W2	0.104 (0.059) (0.093)	-0.032 (0.022) (0.035)	-0.027 (0.026) (0.053)	0.114 (0.023) (0.141)
W3	**0.171*** (0.073) (0.074)	0.033 (0.028) (0.035)	-0.001 (0.032) (0.045)	0.119 (0.028) (0.112)
$\overline{\overline{\rho}}_e$ (CD p-value)	-0.052 (0.000)	-0.032 (0.000)	-0.066 (0.000)	-0.066 (0.000)
Pooled ADF on $\hat{e}_{it}$	175.430	134.619	146.486	146.487
ADF on $\hat{e}_{it}$ $(\widehat{F}_t^k)$	/	/	/	/

Notes: All dependent variables are in natural logarithms. W0 = share of 15-24 year olds, W1 = share of 25-34 year olds, W2 = share of 35-44 year olds, W3 = share of 45-54 year olds, W4= share of 55-64 yea olds (excluded). Standard errors in parentheses. , significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. Driscoll Kraay standard errors are in second row below coefficients in 2WFE, maximum lag considered in autocorrelation is set to 4. Last two rows of each model report results from PANIC on residuals. / indicates no common trends. is average correlation coefficient between cross-country errors, reported together with CD statistics‘ p-value.

Table 7. Level regressions, for the sample of 64 countries, over the period 1950-2017

	Homogeneous panel				Heterogeneous panel			
	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP	ΔY/H	ΔHCH/H	ΔK/Y (α/1-α)	ΔTFP
	CCEP				CCEMG			
ΔA1	0.084 (2.225)	-0.183 (0.633)	-0.183 (1.016)	0.348 (3.099)	-1.570 (1.195)	0.216 (0.545)	0.919 (0.577)	-2.538 (1.910)
ΔA2	-0.758 (1.931)	-0.283 (0.661)	0.153 (1.026)	-0.786 (3.125)	**-2.262‘** (1.306)	0.766 (0.957)	1.355 (0.738)	**-5.420*** (2.131)
	-0.014	-0.013	-0.020	-0.015	-0.015	-0.010	-0.017	-0.017
CD p-value	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)
	2WFE				MG with trend			
ΔA1	0.361 (0.419)	-0.309 (0.168)	-0.296 (0.227)	0.817 (0.586)	-0.610 (1.604)	**0.932*** (0.427)	0.388 (0.540)	-2.228 (2.507)
ΔA2	0.338 (0.397)	-0.323 (0.160)	0.122 (0.212)	0.439 (0.555)	-1.369 (1.216)	0.300 (0.390)	0.137 (0.519)	**-3.176‘** (1.838)
$\overline{\overline{\rho_e}}$	-0.021	-0.011	-0.022	-0.022	0.154	0.048	0.136	0.153
CD p-value	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: All dependent variables are in natural logarithms. A1 = share of 15-34 year olds, A2 = share of 35-54 year olds, A3 = share of 55-64 year olds (excluded). Standard errors in parentheses. , significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. is average correlation coefficient between cross-country errors, CD statistics‘ p-value is reported in last row.

to the 25-34 age group seems to have the most positive effect on labour productivity growth; a shift by 1 p.p. is correlated with 0.27 p.p. higher growth. Shifting from the 55-64 to the 25-34 group has the most positive effect on TFP growth, whereas shifting to the 15-24 age group depresses it by about 0.32 p.p. In this setting, age composition seems to have an insignificant effect on human capital accumulation and only has a significantly positive effect on physical capital formation when shifting from age group 55-64 to 15-24.

Our results suggest that the age structure indeed has a growth and not a level effect. Table 7 reports results from level regressions for the sample of 64 countries, in which we restrict β from equation 4 to be equal to – θ and thus estimate,

$$\Delta y_{it} = \Delta\beta x_{it} + \alpha_i + \lambda_i F_t^{\,k} . \qquad (16)$$

Slope coefficients on the first differences of young and middle-aged groups are insignificant.

Our results speak in favour of the life-cycle theory, hypotheses of adaptation of individuals' behavior to population ageing, and endogenous growth theory. Our findings are also in line with Cooley and Henricksen (2018), whose growth accounting exercise shows that the fastest-ageing G7 countries had a positive growth contribution from higher capital accumulation and negative growth contribution from TFP.

Policy Implications

The share of older individuals in the working-age population will continue to increase in the coming decades. Policy measures, which forestall the negative effect of individuals aged 55-64 on TFP or promote their positive effect on supply of production factors, will be of crucial importance for sustaining the current level of living standards. The extent to which higher domestic savings result in higher domestic investment depends on the relative return on capital at home versus abroad and on openness of the economy. The possible effect of demographic structure on savings thus adds to the importance of ensuring the stability of domestic financial markets and implies that more autonomous economies will be able to deal with ageing in the future. Higher public investment into capital-intensive technologies may also be a plausible reform. Buyse et al. (2017) find that tax incentives, moderately large public R&D subsidies, and investment in tertiary education promote business R&D investment, and thus total factor productivity growth, to the greatest extent. Aiyar et al. (2016) find that higher public R&D spending (but not also private), lower employment protection regulation, and active labour-market policies also forestall the negative impact of workforce ageing on TFP growth. Investment in education may, in addition to promoting TFP growth, also stimulate number of years spent in education, higher spending feeds through easier access to funding or raises the quality of education, and thus increases the return of investment in it. Larger public spending on education may

therefore promote a positive impact of the growing share of older workers on human capital formation. We note that the net effect of public spending on education depends significantly on how it is financed (Agenor and Neanidis, 2011), which not taken into account is in this setting. We introduce a policy measure: government spending on education as a% of GDP (P_{it-1}) as a mediating variable for the impact of 55-64 age share () on human capital per hour growth, $\Delta \frac{HC}{H}_{it}$,

$$\Delta \frac{HC}{H}_{it} = \beta_1 A3_t + \beta_2 P_{it-1} + \beta_3 (A3_t P_{it-1}) + \alpha_i + F_t \,. \qquad (17)$$

Following Ayiar et al. (2016) we include lagged policy variable to reduce endogeneity risk. The partial elasticity of moving from the 15-54 to the 55-64 age group $\beta_1+\beta_3 P_{it-1}$ is . The difference between this partial elasticity and the coefficient on age share in regression without interaction term (Table 8, column 2) indicates the mediation effect of a policy variable. This estimation is based on an unbalanced panel of 62 countries for the period between 1970 and 2017. Data for general government spending on education as% of GDP, which covers current, capital, and transfers from international sources to government, is calculated using data from the UNESCO Institute for Statistics and is available at World Bank's World Development Indicators.

Table 8. The effect of age share 55-64 on the growth rate of human capital per hour worked, for the sample of 62 countries, over the period 1970-2017

Dependent variable	ΔHCH/H	ΔHCH/H
A3	**0.051** (0.019)** (0.022)*	**0.113** (0.042)*** (0.065)*
lP	/	0.003 (0.001)' (0.002)
lP*A3	/	-0.012 (0.007)' (0.010)
R squared	0.003	0.006
CD p-value	**0.050***	**0.090***

Notes: A3= share of 55-64 year olds. Standard errors in parentheses. ' significant at 10%; * significant at 5%; ** significant at 1%; *** significant at 0%. Last row is CD statistics' p-value, * indicates rejection of weak cross-sectional dependence between resiudals at 5% level. In regression in column 2 Breusch-Godfrey test rejects serial correlation at 1% level, whereas Breuch-Pagan detects heteroskedasticity; White corrected standard errors are reported in the second row below coefficients. In regression in column 1, we detect autocorrelation and heteroskedasticity; Newey West adjusted standard errors are reported in the second row below coefficients, maximum lag is set to $T^{0,25}$.

The results in Table 8 highlight the positive correlation between public spending and human capital formation. However, interaction term is statistically insignificant after White correction, implying that public spending on education does not have a statistically significant mediating effect on the impact of age composition on human capital growth. $\beta_1+\beta_3 P_{it-1}$ is equal to -0.282. It seems that if anything, higher government spending on education in% of GDP reduces the positive impact of increasing share of individuals aged 55-64 in working age population on human capital growth, implying public spending on education has a relatively larger positive effect on formation of human capital amongst younger generations.

Conclusion

The results of our analysis highlight a negative correlation between the increasing share of individuals aged 54 to 65 and labour productivity growth, due to their negative impact on total factor productivity growth. The younger generations, particularly those between the ages of 25 and 34 are most positively correlated with TFP growth. This result is robust to different samples and alternative formulation of age proportions. The negative effect of individuals aged between 55 and 64 on TFP growth is offset by their positive impact on the speed of accumulation of physical and human capital, but only to a very limited extent. This effect is, however, less robust. For modelling labour productivity dynamics and its response to changing age composition two ways fixed effects estimator already employed by Ayiar et al. (2016) and Freyer (2007) seems to be the most appropriate, provided slope coefficients are poolable. A cross-sectional dependence of age and macroeconomic variables is a possible source of biased estimates. A significantly reduced variation of the data, from which parameters in two ways fixed effects are estimated, requires careful interpretation of slope coefficients. Considering the rapid ageing of developed economies' workforce, projected for the future, and the already impaired trend of labour productivity growth, policies that forestall the negative impact of older workers on innovation process and promote their positive impact on physical and human capital formation will be of crucial importance for sustaining the current level of living standards. We do not find evidence that higher public spending on education in% of GDP has such an effect. The next step is to identify policy measures, which will mitigate the negative contribution of older workers to labour productivity growth.

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Staranje delovno sposobnega prebivalstva in dinamika produktivnosti dela

Izvleček

Pričujoči članek v okviru neoklasične teorije rasti preučuje vpliv starostne strukture delovno sposobnega prebivalstva na produktivnost dela ter na njene determinante. Ekonometrična analiza temelji na podlagi panelnih podatkov 64 držav med leti 1950 in 2017. Naš prvi prispevek izvira iz testiranja ali šok v starostni strukturi permanentno spremeni dinamiko produktivnosti dela. Iz metodološkega vidika se prispevek navezuje na zmanjšanje tveganja napačne določitve funkcijske oblike regresijskega modela. Obstoječa literatura namreč zanemarja možnost presečne odvisnosti podatkov in heterogenost regresijskih koeficientov. Opozorimo tudi na pomembnost analiziranja lastnosti časovnih vrst za korektno statistično sklepanje. Rezultati nakazujejo, da staranje delovno sposobnega prebivalstva zavira rast produktivnosti dela; negativen prispevek posameznikov, starih med 55 in 64 let, k rasti skupne faktorske produktivnosti pa je le delno kompenziran s strani njihovega pozitivnega prispevka k formaciji fizičnega in človeškega kapitala. Za ohranjanje trenutnega življenjskega standarda je ključnega pomena sprejetje ekonomskih politik, ki zavirajo negativen vpliv starejših delavcev na inovacijski proces in spodbujajo njihov pozitiven vpliv na ponudbo proizvodnih dejavnikov. Ne najdemo dokazov, da ima višja javna poraba za izobraževanje v % BDP takšen učinek.

Ključne besede: produktivnost dela, demografija, neoklasična produkcijska funkcija, panelni podatki

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Consumer Perceived Risk by Online Purchasing: The Experiences in Hungary

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Abstract

The aim of this paper is to identify and categorize the perceived risks that Hungarian consumers connect with online purchasing. The research is based on empirical data collected via a questionnaire and analysed with statistical software. The applied exploratory factor analysis identified five risk categories connected to online purchasing: perceived after-sale risk, perceived data security risk, perceived delivery risk, and perceived product risk. The fifth risk factor seems the most characteristic to Hungarian customers, who are wary of the possibility of online vendors selling fake products on the Internet. The results offer valuable information to companies engaged in online vending concerning the risk factors Hungarian consumers associate with online shopping. One limitation of this study is that it does not evaluate risk-reducing strategies.

Keywords: perceived risk, perceived risk types, online shopping, consumers´ purchasing behaviour, exploratory factor analysis

Introduction

Online shopping has become an intrinsic part of life in the 21st century. More and more consumers are discovering the advantages of purchasing goods via the Internet (Bányai & Novak, 2011). The Internet allows consumers to shop anytime, anywhere, with the ability to compare products and prices with a few clicks, and to read the experiences of other buyers with the desired product and the selected webshop. 63% of the European Union´s population purchased goods online in the last 12 months in 2019, with the highest proportions seen in the UK (87%), Denmark (84%), and Sweden (82%). This compares with 22% in Bulgaria, 23% in Romania and 34% in Serbia (Eurostat, 2020). In Hungary, the e-commerce turnover has been increased since the turn of the millennium (Veres, 2018). In 2018, 5.4 million consumers – or 91% of the adult population – purchased goods online (eNet, 2019). The capacity to raise the number of online shoppers in any large-scale manner in Hungary is minimal; hence, the expansion of e-commerce must rely on shopping intensity.

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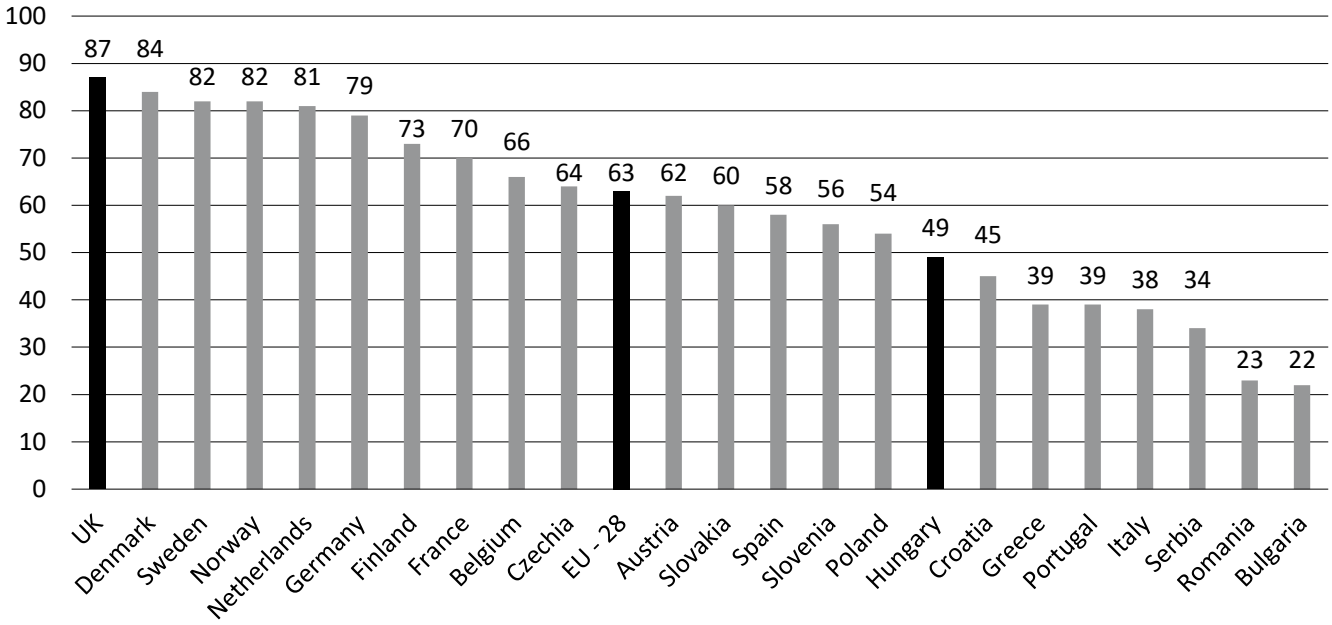
Table 1. Online purchase in the last 12 months in the European Union in 2019 (percentage of individuals)



Source: Eurostat, 2020.

The technical, legal, and security requirements of the online shopping have developed steadily over the past two decades. The Internet has become a highly regulated sales channel in the EU. One priority of the European Commission is to ensure safe Internet for all citizens. The development of comprehensive legal framework, the rise of the capacity of law enforcement authorities, and better assistance to victims are the instruments in the EU to combat cybercrime (European Commission, 2020). This would indicate a low risk environment for consumers. Despite these developments, the international crime statistics show a grow in the Internet connected fraud (e.g. credit card fraud, non-payment, non-delivery). In Austria, one of the neighbouring countries of Hungary, the number of Internet fraud cases increased by 313% from 2010 to 2018 (Crime Statistics 2018 of the Federal Ministry Austria, 2019). The National Crime Agency of the United Kingdom reported about 1 million computer misuse offences in 2019 (NCA National Strategic Assessment, 2019). The European Central Bank (ECB) also recognises the increase of credit card fraud; ´23 million stolen credit cards are for sale on the dark web in the first half of 2019´ (IOCTA, 2019). Accordingly, consumers continue to associate purchasing goods online with risk, which ´has an impact on their willingness to use online services´ (European Commission, 2020). At buying online, consumers focus more on avoiding potential risks than on maximising benefits (Kiss & Faragó, 2013). Customers are concerned not only about fraudulent activities, but also the lack of physical trials and the absence of personal contact with sales personnel (Dai, Forsythe & Kwon, 2014). Furthermore, uncertainties could result from perceptual bias as well. Such perceptual bias could arise out of selective attention, selective distortion, and selective memory of the costumers (Kotler, & Keller, 2012).

The empirical research in this paper aimed to explore whether and to what extent Hungarian consumers perceive risks when shopping online. It also sought to uncover latent variables behind the risk items defined in this context. After analysing the results of international publications and following internal discussion about relevant risks in the Hungarian market, a risk catalogue with 23 risk measurement items were generated. 162 questionnaires were used for statistical analysis. The study employed an exploratory factor analysis (EFA) via the extraction method of principal axis factoring to attain its research aims of exploring whether any latent variables behind the risk items exist.

Theoretical Background

In 1960, Harvard Business School Professor Raymond Bauer posited that consumer behaviour can viewed as an instance of risk-taking. He hoped his theory would attract the attention of researchers and practitioners and that it would, thereby, survive its infancy. Over the past 60 years, the perceived risk concept has become a highly researched and successively extended area. Cunningham (1967) reported a two-component model containing the following dimensions: uncertainty and dangerousness of consequence. Roselius (1971) discovered that consumers have preferences for different methods of risk reduction associated with

various types of loss. Jacoby and Kaplan (1972) documented the five types of perceived risk: performance, physical, psychological, social, and financial. Concurrently, Roselius added the "time" dimension to the risk type concept. With the rise of the product diversity and of the communication noise around them, it became difficult for the costumer to be perfectly informed about product offers (Kolos, 1997). Risks connected to conventional sales channels were deeply researched by W.V. Mitchell in the 1990s. He stated that consumers are often more motivated to avoid mistakes than they are to maximise utility (Mitchell, 1998). Kotler & Keller (2016) describe six risk types: functional, physical, financial, social, psychological, and time risks.

Online shopping behaviour of consumers started to be analysed at the beginning of the 1990s. The impact of perceived risk on shopping attitudes has been examined in an increasing number of empirical studies (Pelaez, Chen, Ch-W. & Chen, Y.X., 2017; Iconaru, Perju & Maconvei, 2012). The work of Forsythe and Shi (2003) must be mentioned in connection to this. Their research identified four types of perceived risk that were important for online shoppers: financial, product performance, psychological, and time/convenience/loss risk. The findings demonstrated that perceived risk theory is a useful concept to explain barriers to online shopping. Since that time, numerous studies and even quantitative meta-analyses have been conducted.

The present study mostly considered empirical research studies conducting factor analysis. International publications reported the different kinds of risk categories that consumers link to online shopping (Pi & Sangruang, 2011; Zhang, Tan, W., Xu, Tan, G., 2012; Zheng, Favier, Huang & Coat, 2012; Masoud, 2013; Almousa, 2014; Gerber, Ward & Goedhals-Gerber, 2014; Hsu & Luan, 2017; Bhatti, Saad & Gbadebo, 2018; Nawi, Mamun, Hamsani & Muhayiddin, 2019). The literature generally favours the negative relationship between the variable perceived risk and intention to purchase; however, some studies have not found this relationship to be significant or even positive (Pelaez et al., 2017). According to Zhang et al. (2012), five independent dimensions significantly affect online purchase behaviour in China: perceived health, quality, time, delivery, and after-sales risks. Zheng et al. (2012) analysed ten risk dimensions in China: performance, privacy, source, delivery, time, financial, payment, physical, social, and psychological. These ten dimensions were classified into two main risk factors: personal and non-personal. A research paper from Taiwan reported that convenience, physical, performance, and social risk factors have the greatest effect on online shopping attitude (Pi & Sangruang, 2011). Masoud (2013) revealed that financial risk, product risk, delivery risk, and information security risk negatively influence online shopping behaviour. Other dimensions in scope (time and social risk) have no effect on online shopping. Gerber et al. (2014) investigated six perceived risk types in Southern Africa: functional, physical, financial, social, psychological, and time risks. They stated that risks perceived by their respondents can be grouped into three risk factors: personal, social, and performance risks. Several studies conducted on this topic exist for the Indian online market, where a negative impact of the risks on online shopping was detected (Suresh & Shashikala, 2011, Dash, 2014, Sreya & Raveendran 2016). Suresh and Shashikala (2011) identified six risk factors: monetary, performance, time, source, social, and psychological risks. The study found that all of the mentioned factors have a significant impact on online shopping attitude. Dash (2014) described six major risk factors in India as well, but with slightly different factors. In addition to product risk, psychological risk, and time risk, he identified financial risk, performance risk, delivery capability risk, and website performance risk. Durmus, Ulusu & Akgun (2017) analysed the effect of perceived risks on online purchase intention through word of mouth (WOM) and trust dimensions in Turkey. The study showed that information risk, financial risk, product risk, and WOM intensity effects trust and finally the online purchase intention. The findings of a Malaysian study revealed that perceived after-sales, financial, psychological, and social risks had a significant effect on the online purchase behaviour (Nawi et al., 2019). In contrast, a Hungarian study claims, consumers face no risk when purchasing goods in Hungarian online shops other than those of the payment and delivery methods (Szűcs, 2018).

For this paper, an online purchase is defined as the following: a consumer orders the desired product/service virtually via a mouse click or email through a webshop operated by the seller (Nagy & Keller, 2017). The American Psychological Association defines the term ´perceived risk´ as the ´individual's subjective assessment of the level of risk associated with a particular hazard (e.g., health threat). Risk perceptions vary according to factors such as past experiences, age, gender, and culture´ (APA Dictionary, 2020). Risks in connection with purchasing are always subjective, perceived risks. (Hofmeister-Toth, 2017). It might be even the case that the risk does not exist or is not present in a purchase decision, but the consumer feels it is real.

The focus of the present paper is on the perceived monetary, product, privacy, time, delivery and after-sales risks. The definitions of the different risk types are very heterogenous in the reviewed research papers. Perceived risks in connection with loss of money were named in the literature as monetary risk or financial risk or economic risk. Potential loss resulting from unforeseeable costs added to the original product price are also part of the monetary risk. In some studies, this risk type covers losses in connection with fraud

such as credit card abuse, personal information disclosure, and products not received. Risks in connection with the expected product performance are named in the literature as product risk or quality risk or performance risk or functional risk. Perceived time risk covers all kinds of losses associated with wasted time, such as time loss resulting from information searches and transaction processing as well as product delivery, replacement, or repair. Risks in connection with data security cover the loss resulting from the fact that unauthorized people may use personal information without the agreement of the consumer. Perceived delivery risks are connected to the loss resulting from an inadequate delivery (wrong delivery place, damaged goods, long delivery time, etc.). Some definitions in the literature includes packaging and transport handling as well (Masoud, 2013). Perceived after-sales risks are connected to the potential loss resulting from the difficulties at contacting the seller and at consumer rights enforcement.

Methodology

The measurement items were based on the research design of Zhang et al. (2012). After internal discussions, the items were adapted for the Hungarian conditions. The questionnaire was tested by 25 Faculty of Economics students at the University of Sopron. After this pre-test, some small modifications were made in the questionnaire. The risk items were measured with a Likert bipolar scale of 1-5 ranging from “strongly agree” to “strongly disagree”. Data collection was performed by students in November 2019 (before the unprecedented COVID 19 lockdown of the economy in Hungary). Each student was instructed to ask four other people in pre-defined age categories to fill in the research questionnaire. A total of 260 questionnaires were distributed to students. Of these, 172 were returned. Four questionnaires missed answering half of the questions. Another six were returned unfilled with the declaration that the person does not buy products online. In the end, 162 questionnaires were analysed with SPSS 22.

Demographical composition of the study sample is presented in table 2.

Table 2. Demographic characteristics of the study respondents

Variable	Frequency	%
Age		
-25	57	35,19
16-40	31	19,14
41-60	45	27,78
61-	29	17,90
Gender		
Male	64	39,50
Female	98	60,50
Education		
Primary school	2	01,20
Skilled worker qualification	28	17,30
High school	89	54,90
Academic degree (BA, MA, PhD)	43	26,50
Family status		
Married	63	38,90
Relationship	51	31,50
Single	48	29,60

Originally, 23 risk items were included in the questionnaire. After internal discussion, two risk dimensions were excluded from the research design, as the questions essentially suggested the answer, which would have been inappropriate. The remaining 21 risk dimensions were yielded into the SPSS software for EFA.

The present study followed the general EFA procedure (Field, 2012), which included an initial data screening followed by factor extraction and factor rotation as part of the main analysis and reliability analysis afterward.

The sampling adequacy measured by the KMO (Kaiser-Meyer-Olkin) criterion for this EFA was 0.749. A KMO statistic ´close to the value 1 indicates the patterns of correlations are relatively compact´ (Field, 2012). Kaiser (1974) recommends values greater than 0.5 as acceptable. Bartlett’s test is relevant for sampling adequacy. As shown in Table 8,

Table 3. Sampling Adequacy Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,790
Bartlett's Test of Sphericity	Approx. Chi-Square	1233,785
	df	210
	Sig.	0,000

the Bartlett's test p value was 0.000. These results confirmed the questionnaire data were acceptable for the continuation of the analysis.

Table 4. Rotated Factor Matrix

	Rotated Factor Matrix[a]				
	Factor				
	1	2	3	4	5
Difficulty reaching the seller	,867				
Difficult consumer rights enforcement	,819				
Long waiting time at replacement	,580				
Expensive sending back process	,499				
Inconvenient warranty enforcement	,477				
Abuse of telephone number		,857			
Abuse of email address		,783			
Abuse of bank card		,696			
Abuse of personal data		,390			
Wrong delivery location			,778		
Product lost at delivery			,737		
Product damaged at delivery			,549		
Long delivery time			,442		
Discrepancy between quality and description				,768	
Lack of product trial				,540	
Difficult judgement of quality				,370	
Counterfeit product					,526

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

An appropriate extraction method is required to identify the factors. The literature and SPSS contain several possibilities for this purpose. In general, Maximum Likelihood or Principal Axis Factoring methods supply the best results, depending on distribution of the underlying data (Osborne, 2014). Some software contains commands to directly execute the multivariate normality distribution analysis. The software used in this study does not directly support such calculations. Therefore, a method described by Arifin was applied, which is a graphical assessment of normality by chi-square versus Mahalanobis distance plot (Arifin, 2015). The assessment indicated the use of the Principal Axis Factoring method to extract the factors.

Unrotated results from a factor analysis are difficult to interpret. To improve the interpretability of the factors, a commonly used rotation method, the Varimax rotation (Osborne, 2014), was chosen. For a clear factor view, factor loadings less than 0.36 were suppressed.

The first analysis was conducted in respect to the communalities. As a result, one item measuring monetary risk and one measuring time risk were removed from the model. In the second round, it was necessary to remove an additional monetary risk item and one product risk from the model. Removing these items resulted in increased KMO statistics. Table 4 displays the factor structure following these steps.

The variance contributions are shown in Table 9. The five risk factors explain 52.4% of the variance in the analysed data.

Once this acceptable structure was in place, reliability analysis was conducted. Reliability analysis results showed that Cronbach Alpha coefficients were satisfactory for factor 1 (=0.805), factor 2 (=0.824), and factor 3 (=0.788). Factor 4, containing product risk items, had a relatively low reliability value of 0.583. Factor 5 had only one item. The KMO statistic (=0.806) of the final model has a ´meritorious value´ (Field 2012).

Table 5. Variance contributions

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5,144	30,258	30,258	4,735	27,852	27,852	2,625	15,442	15,442
2	2,01	11,821	42,079	1,606	9,446	37,298	2,196	12,920	28,362
3	1,585	9,323	51,402	1,223	7,197	44,495	1,774	10,434	38,796
4	1,305	7,679	59,081	0,812	4,779	49,274	1,389	8,172	46,968
5	1,132	6,661	65,742	0,535	3,146	52,421	0,927	5,453	52,421

Results

The structure of the rotated factor matrix shows a clear picture of the latent risk factors. Factor 1 contains the items connected with after-sales concerns of consumers. It includes the items in respect of the difficulties with reaching the vendor; the enforcement of legal provisions; the additional costs of returning the purchased good and the long waiting time in case of replacement. Factor 2 includes the items in connection with the loss of personal information, e.g. the telephone number, the email address, the bank card information and any other personal data. Factor 3 shows the perceived risk items resulting from an inappropriate delivery process, e.g. wrong delivery place, lost products and long delivery time. The item "product damaged at delivery" correlates with the delivery risk factor and with the counterfeit product factor. Thematically, this item is related to delivery process; this is the reason why this item is connected to factor 3 in the model interpretation. Factor 4 represents the items linked to risk in connection with the product attributes: the discrepancy between the described and personally perceived quality of the product; the missing possibility of trying the product and the difficulty of measuring the quality via Internet. Factor 5 represents the "counterfeit product" item.

Findings

The EFA results revealed two findings. *First, t*ime risk items were linked to the underlying online purchase processes (to the delivery and after-sales processes). Respondents perceived the items measuring the time aspect as part of the underlying processes and not as a separate "time" risk factor.

Second, the "counterfeit product" risk dimension did not become part of the financial factor model as it did for example in the survey of Zhang et al. in 2012. Additionally, this item does not correlate with any other analysed risk items. Consumers struggle to assess product originality. Nevertheless, this is a decidedly important product characteristic, especially if the product is a special and expensive brand. This issue seems to matter to Hungarian respondents particularly. This concern is not only a Hungarian topic. There is a rising number of internationally developed methods and patents to fight the selling of counterfeit products, e.g. Blockchain-based applications for product anti-counterfeiting (Ma, Li, Chen, X., Sun, Chen, Y. & Wang, 2016), or use of authentication keys and authentication server (US Patent US10558979B2, 2020).

Conclusions

The study results demonstrated that Hungarian consumers do perceive risks with online shopping. Hungarian consumers are especially worried about the possibility of being unable to contact the seller after purchase and not-receiving the expected after-sales service from the seller. Data security concerns of the respondents are followed by the potential problems at delivery process. Difficulty in assessing product quality online is another factor on which Hungarian consumers focus. The perception of some risks is unambiguously connected to the underlying processes (e.g. time risk to delivery and after-sales processes). The risk of purchasing a counterfeit product is one of the most striking concerns of Hungarian respondents. Consumer attitudes toward risks could be used as a segmentation dimension in Segmentation-Targeting-Positioning (STP) marketing attempt. Furthermore, it would help to further sharpen the focus on the worries of online costumers which could help to adequately design the marketing communication mix and to increase the individual´s shopping intensity.

Lessons learned from the research include: the analysis of perceived risk could be divided into product categories; the number of risk items per hypothesized risk could be augmented; health risk could be included into the risk items; dependence of risk perception and buying willingness/trust/ etc. could be analysed; risk reducing strategies could be included into the research design for enhancing the practical usage of the study. After identification of the risks in the different purchase processes, the two-component model of Cunningham (1967) can be followed as well (where the perceived risk items are conceptualized as the uncertainty {probability of loss} and the consequences {importance of the possible negative consequence} of the purchase).

Extraordinary situations like the current COVID-19 pandemic can hypothetically induce changes in risk perceptions in online shopping. With the development of the online purchasing community and the increasing number of people joining this community, it is expected that risks will be revealed and that sellers or regulators will work to reduce these risks to an acceptable (minimal) level.

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Tveganje pri spletnem nakupovanju, zaznano s strani potrošnikov: izkušnje Madžarske

Izvleček

Cilj prispevka je identifikacija in kategorizacija tveganj, ki so jih zaznali madžarski potrošniki v povezavi s spletnim nakupovanjem. Raziskava temelji na empiričnih podatkih, zbranih s pomočjo vprašalnika in analiziranih z uporabo programa za statistično analizo. Pojasnjevalna faktorska analiza je identificirala pet kategorij tveganj, povezanih s spletnim nakupovanjem: zaznano poprodajno tveganje, zaznano tveganje glede varnosti podatkov, zaznano tveganje glede dostave in zaznano tveganje glede izdelka. Peti dejavnik tveganja se zdi najbolj značilen za madžarske kupce, ki jih skrbi, da spletni trgovci prodajajo ponarejene izdelke na internetu. Rezultati nudijo dragocene informacije podjetjem, ki se ukvarjajo s spletno prodajo, glede dejavnikov tveganja, ki jih madžarski kupci povezujejo s spletnim nakupovanjem. Omejitev te študije je, da ne vrednoti strategij za zmanjšanje tveganja.

Ključne besede: zaznano tveganje, zaznane vrste tveganj, spletno nakupovanje, nakupno vedenje potrošnikov, pojasnjevalna faktorska analiza

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Key Performance Indicators and Industry 4.0 – A Socially Responsible Perspective

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Abstract

The main aim of this contribution is to outline the role and importance of key performance indicators in the frame of Industry 4.0 implementation. These key performance indicators are presented as a cornerstone for industry 4.0 implementation in organizational practice, since they represent key input for needed data in digitalized organization. In that framework, the contribution first exposes some of the essential characteristics of "Industry 4.0", followed by the methodology of key performance indicators (KPI). Next, the contribution outlined a proposed methodology for implementing KPIs in frame of Industry 4.0 adoption in organizations. Another section of the paper is dedicatd to the linkage between corporate social responsilbty and KPIs in frame of Industry 4.0. The paper also outlines implications, limitations and further research directions are outlined.

Keywords: Industry 4.0, key performance indicators (KPI), social responsibility

Introduction

The term "Industry 4.0" was first introduced at the Hannover Messe Fair in 2011. Industry 4.0 (I4.0) can be defined as »real-time, intelligent, and digital networking of people, equipment and objects for the mangement of business processes in organizations« (Dombrowski et al., 2017). Since the emergence of this new phenomenon, there has been a constant increase of literature on Industry 4.0. It addresses theoretical discussions about the phenomenon of Industry 4.0 (Drath & Horch, 2014; Weyer et al., 2015); case studies on the implementation of Industry 4.0 principles in various industries (Oliff & Liu, 2017; Caricato & Grieco, 2017;

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Kuo, 2017); the role and importance of lean management for implementation of Industry 4.0 (Sony, 2018; Mayr et al., 2018); and linkages between implementation of Industry 4.0 and sustainable development (Varela et al., 2019; Duarte et al., 2020).

Despite growth of the body of literature, several issues need to be addressed with regards to the implementation of Industry 4.0 into the practice of organizations. One such challenge is the role and importance of key performance indicators (KPI) in the process of Industry 4.0 implementation. There is literature on KPI, but it is not linked to the Industry 4.0 implementation. Thus, literature offers definitions of KPI (Ballard, 2013; Bishop, 2018, ISO 22400), case studies of implementation of KPIs in organizations, etc.

The role of KPI in implementing Industry 4.0 was neglected in the literature, although KPIs are of huge importance when implementing Industry 4.0 principles. The role of KPI is crucial when organizations prepare blueprints for implementation of Industry 4.0 practices, i.e. defining KPIs, which are foundation for measuring key points in the process and are thus building blocks for measures established in frame of digitalized organizations.

The main aim of this contribution is to outline the role and importance of key performance indicators (KPIs) in frame of Industry 4.0 implementation, while also considering the linkage between corporate social responsilbty and KPIs in frame of Industry 4.0, which has not yet been addresesed in the literature. The paper contributes the following: First, it highlights the role and importance of KPIs in the process of Industry 4.0 implementation. Second, it outlines the theoretical framework for implemenation of Industry 4.0, from identification of KPIs to their implementation. Third, it establishes the linkage between corporate social responsibility and KPIs in frame of Industry 4.0. Finally, it offers recommendations for implementaiton, as well as some directions for further research in this area.

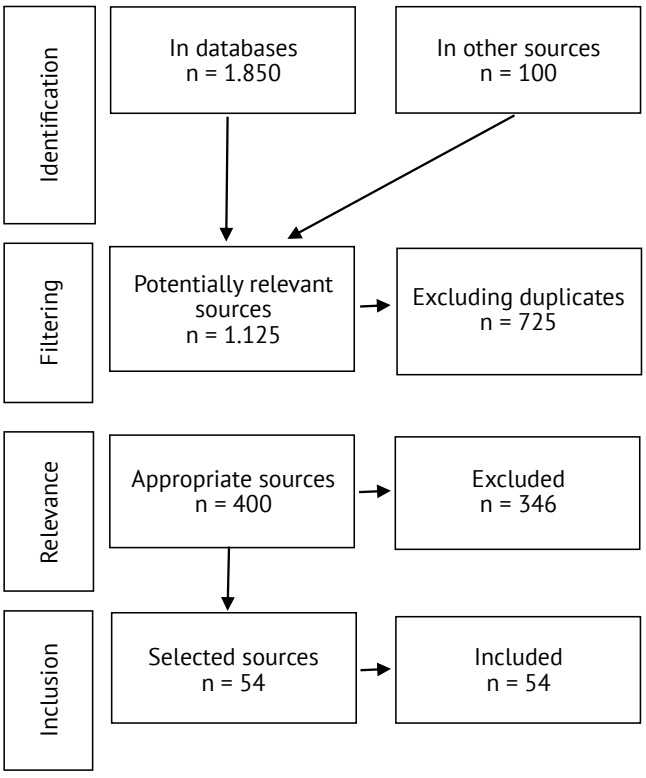
Methodology and Research Approach

In line with identified challenges in Industry 4.0, we proposed the following research question: How can KPIs contribute to a healthy and socially responsible implemenation of Industry 4.0 in organizations? The methodology used is M. Mulej‘s Dialectical Systems Theory. The structure matches the above overview of the main issues.

Based on a systematic literature search strategy, the databases dLib.si, ProQuest and Cobbis.si were reviewed in 2018. The literature was searched using the following keywords: “Industry 4.0,” “KPIs,” and “social responsibility.” We broaden our search of the literature on the management and systems theory (in conjunction with requisite holism by systemic approach). The limitation resulted from outflow year for the search, because the study covered only publications since 2010; such restrictions were deliberately set, because we wanted to obtain the latest and must current information on the issues. We focused on articles published in Slovenian and English. There were no further restrictions.

Authors researched in the databases of the University of Maribor. Qualitative research methodology, including desk research, which was based on systems theory (Šarotar Žižek & Mulej, 2015), Mulej’s Dialectical Systems Theory (Mulej & Dyck, 2014) and the law of requisite holism was used. The search in the databases of the University of Maribor resulted in 1.850 hits. We selected and included 54 sources and researched them; see Figure 1.

Figure 1. Research process flowchart



Quality score review and description of the data processing

The selected sources were published between 2010 and 2018. We excluded the sources that were duplicated or where we estimated the content was not sufficiently connected to

the subject, purpose, or objective of our research. For the analysis of the technical and scientific content, we synthesized the results and took into account the availability content and contextual relevance. We chose 54 sources that were appropriately connected with our topic and objectives and contribute with high quality to our research.

Industry 4.0 (I4.0)

I4.0 symbolizes the beginning of the fourth industrial revolution, which is the first revolution that has been announced ahead of its inception. Based on concepts and technologies that include cyber-systems, the internet of things (IoT) and the internet of services, processes in I4.0 include interconnections of the virtual, digital and physical worlds and the learning in production. These connections include machines, products, services, information and communication systems, and staff. The result of I4.0 is a more efficient, adjusted and individualized production.

The essence of I4.0 is a comprehensive and structured use of the digital networking of the creation, logistics and use of products and services. The promoters of I4.0 expect this will lead to significant improvements in industrial processes in manufacturing, engineering, material use, supply chain, and life cycle management.

The essence of the joint program – the platform of the German government and the representatives of its industry sector – I4.0 (in German: Industrie 4.0) lies in a comprehensive and systematic digital networking of the creation, logistics and use of products and services (Hennies & Raudjärv, 2015), aimed to gain power in global production (Sanders et al., 2016).

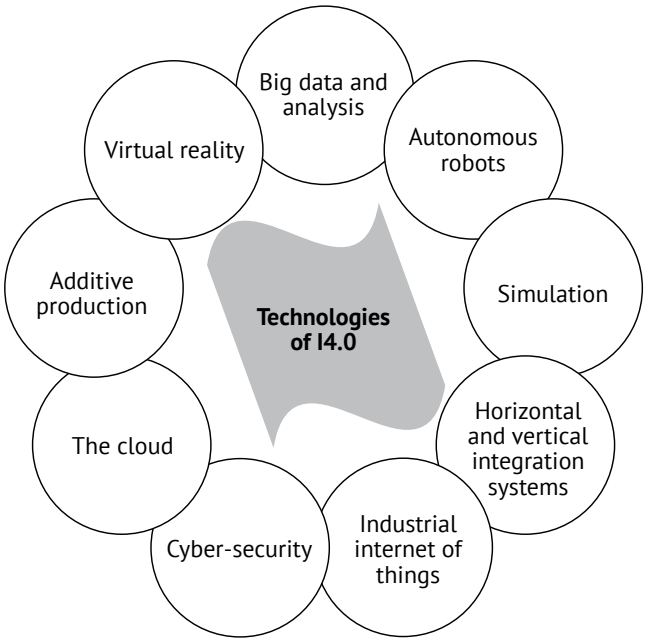
I4.0 is often described as an incentive for the fourth industrial revolution (Hennies & Raudjärv, 2015), or equated with it (e.g. Kamensky, 2017; Dais, 2014). After Hermann and co-authors (2016), I4.0 presents two aspects: 1. this industrial revolution was the first one announced *a priori*, and not observed *ex post facto* (Drath & Horch, 2014); 2. one expects a large economic impact from this industrial revolution, because I4.0 promises increased operational efficiency as well as the development of entirely new business models, services and products (Kagermann et al., 2013; Hair et al., 2014).

Other authors (Alexopoulos et al., 2016; Qin, Liu, & Grosvenor, 2016; Li, 2017) have mentioned thad Industrie 4.0 is also called Industry 4.0 which symbolises the beginning of the Fourth Industrial Revolution. Li Da Xu and coauthors have summarized many authors (Hermann, Pentek, & Otto, 2016; Jasperneite, 2012; Kagermann, Wahlster, & Helbig, 2013; Lasi et al., 2014; Lu, 2017a, 2017b) who have said that Industry 4.0 represents the current trend of automation technologies in the manufacturing industry, and it mainly includes enabling technologies such as cyber-physical systems (CPS), the Internet of Things (IoT), and cloud computing. For our research, GTAI's definition (2014) is also important, as it reveals that Industry 4.0 represents the technological evolution from embedded systems to cyber-physical systems.

Rüßmann and the other authors (2015) define nine technologies of I4.0 (Figure 2):

1. Big data and analysis
2. Autonomous robots
3. Simulation
4. Horizontal and vertical integration systems
5. Industrial internet of things
6. Cyber-security
7. The cloud
8. Additive production
9. Virtual reality

Figure 2. Technologies of I4.0



Dalenogare and coauthors (2018) have mentioned these technologies of the Industry 4.0: (1) Computer-Aided Design and Manufacturing (CAD/CAM), (2) Integrated engineering systems (ENG_SYS), (3) Digital automation with sensors (SENSORING) (4) Flexible manufacturing lines (FLEXIBLE), (5) Manufacturing Execution Systems (MES) and Supervisory control and data acquisition (SCADA), (6) Simulations/analysis of virtual models (VIRTUAL), (7) Big data collection and analysis

(BIG DATA), (8) Digital Product-Service Systems (DIGITAL-SERV), (9) Additive manufacturing, fast protoyping or 3D impression (ADDITIVE) and (10) Cloud service for products (CLOUD).

The concept of I4.0 describes various changes in production systems, which are mostly supported by information technology (IT). These changes have not only technological but also organizational effects. They will mean a change in orientation from production to service in the whole traditional industry. The concept of I4.0 refers to the set of current concepts, which cannot be clearly classified and, in particular, cannot be accurately distinguished in individual cases. These concepts are shown in the Figure 3 (Lasi et al., 2014; summarized after Čančer 2018):

- **Smart factory:** smart technology will be used to operate a smart factory, which will support the management of complex systems and processes. The production will be equipped with sensors and autonomous systems. Communication between machines, products, people and other resources will take place in a similar manner as in social networks. It will be supplemented by communicating of customers with facilities in a smart factory and by communicating with the supply chain.
- **Cybernetic-Physical Systems:** This is a combination of physical and program levels. After inclusion in production, the systems will no longer suffer from a strict separation between software and hardware.
- **Self-organization:** Existing production systems are becoming increasingly decentralized and self-organized. This coincides with decomposition of the usual production hierarchy.
- **New approaches in distribution and ordering:** Distribution and ordering will be increasingly individualized.
- **New approaches to the development of products and services**: The development of products and services will be individualized.
- **Adapting to human needs**: The new production systems will be designed to follow human needs, and not vice versa.
- **Corporate social responsibility** is increasingly at the core of the design of industrial production processes.

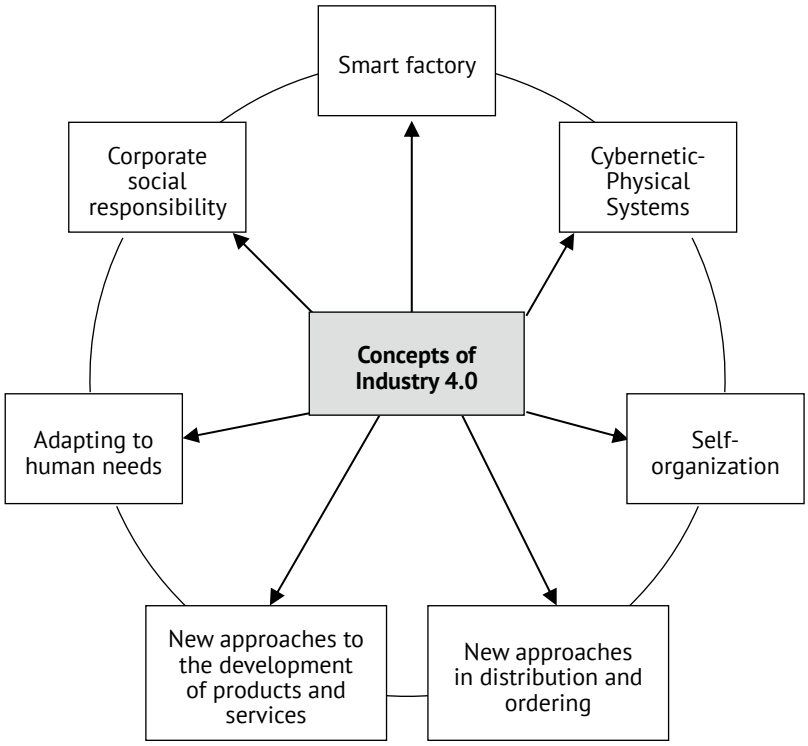
Components of I4.0 are after Hermann and coauthors (2016):

- Cyber-Physical Systems (CPS),
- Internet of Things
- Internet of Services
- Smart Factories

In order to support companies in the definition and construction of I4.0 systems, the general principles for the design of I4.0 (Hermann et al., 2016) are as follows:

- **Interoperability:** the ability of machines, devices, sensors and people to connect and communicate with each other through the Internet of things or the Internet of people.

Figure 3. Concepts of Industry 4.0



Source: Lasi et al., 2014; summarized after Čančer, 2018

- **Information transparency:** Information systems must be able to create a virtual copy of the physical world, enriching it with data derived from sensors. This requires the implementation of raw data obtained from sensors into higher value information.
- **Technical assistance:** The ability of support systems to support decision-making for people by combining and visualizing data. The data are processed so as to be understandable to the people / employees and make it easy to make informed decisions in the shortest possible time. The technical assistance is also the ability of cybernetic-physical systems to physically support people in carrying out tasks that are unpleasant, too hard or too dangerous for humans.
- **Decentralized decisions**: The ability of cybernetic-physical systems to make decisions about their own systems and the decisions that are necessary for the autonomous performance of the tasks envisaged. Aside from some exceptions, disruptions or conflicting objectives, the decision-making requirement is transferred to a higher level.

Hermann and coauthors (2016) have prepared a table in which are six design principles that can be derived from the I4.0 components.

Table 1. Design principles of each Industry 4.0 component

	Cyber-Physical Systems	Internet of Things	Internet of Services	Smart Factory
Interoperability	x	x	x	x
Virtualization	x	-	-	x
Decentralization	x	-	-	x
Real-Time Capability	-	-	-	x
Service Orientation	-	-	-	x
Modularity	-	-	x	-

Source: Hermann et al., 2016

Regarding the challenges of the I4.0, employees are expected to:
- have the necessary knowledge on processes and their use;
- have specific competences to perform work in I4.0. The company must define the required competencies according to the specificity in accordance with strategy 4.0;
- become even more flexible in terms of working time and location, and also in terms of how they face tasks and problems;
- assume much greater responsibility for work and self-initiated knowledge, and collaborate with each other effectively;
- perform a number of tasks (the type of work will be important, not the location - companies will have to consider modifying job descriptions).

The number of routine physical tasks will be (markedly) reduced, while on the other hand, there will be more jobs that require flexibility, problem solving and creativity.

In order to manage and control I4.0, performance indicators are necessary. In the following, we highlight the methodology of key performance indicators.

Key Performance Indicators (KPI)

Why should organizations implement key performance indicators? There is a permanent need to monitor efficiency and effectiveness and a quick and clear overview of the current situation. The requirements of digitization and I4.0 indirectly compel us to do so. We also use key performance factors because a wide range of indicators for comprehensive monitoring of the situation is expanding, as well as the need to integrate fragmented data, ensuring data compatibility across different systems in organizations and in different databases (Matlab, Ms Access, SQL).

A performance measurement system is important. It consists of a set of procedures and indicators that precisely and constantly measure the performance of activities, processes and the organization as a whole, and is a vital aspect in regard to the management of companies (Neely et al., 2005; summarized after Varisco et al., 2018). Lohman (2004; summarized after Varisco et al., 2018) mentioned that a performance measurement system should be able to provide data for monitoring both past and the future performance, to strengthen the strategies and avoid introducing the conflicting indicators, and to support providing data for benchmarking. Therefore the performance measurement system focuses not only on financial procedures and indicators, but also on consumers' aspects or internal processes.

Parmenter (2007) connected a performance measurement system with key performance indicators (KPI). He says that key performance indicators are considered the core of the performance measurement system: they are defined as a set of measures that focus on the main critical activities. Key performance indicators (KPi) are critical to understanding the performance of organization and to the decision-making. They are used by almost all types of businesses by managers, to evaluate effectiveness in achieving strategic and operational goals (Bishop, 2018).

KPI are not only financial but also non-financial indicators that organizations use in order to estimate and define how successful they are, aiming at previously established long-term lasting goals (Velimirović, Velimirovic & Stankovič, 2010). Velimirovič and co-authors (2010) mentioned that

KPI are static and stable indicators that carry more meaning when comparing information. Therefore KPI help to remove the emotion from object of the business, and allow workers focus on the things that joy is really about, and that are making benefit.

„Quantitfiable level of achieving a critical objective. KPI are derived directly from or through an aggregation function of, physical measurements data and/or other key performance indicators.“ (ISO 22400-part I). »ISO 22400 defines a KPI by giving its content and its context.

- Content: a quantifiable element with a specific unit of measure (including the formula that should be used to derive the value of the KPI);
- Context: a verifiable list of conditions that are met«.

The selection and implementation of KPI is influenced by the organizational structure (line-line or process organizational structure or some other), as well as the type of production process, such as non-serial or serial production. Management in a production company is of utmost importance. The extensive and complex production processes can be managed in a transparent and efficient manner with a proper management hierarchy, which includes, in addition to the process and business levels, the production level of management. Management in a production company is based on a system for managing and controlling production processes. An example of such a system is MES, which is usually also computerized and includes classification, data transfer and optimization, allocation and resource status, and document management.

Zorzut (2009, 27) points out that the indicators are at different levels of corporate governance. The lowest level covers individual devices, control loops, process cells, etc. This is followed by the production level, on which one monitors the entire production line or plant. At the highest level, there is the business level, where the business of the whole company is managed.

The dimensions of indicators are as follows (Lohman 2004; summarized after Zorzut, 2009, p. 26):

- The **name** of the indicator.
- **Objective:** Describes the meaning and purpose of using the indicator so that the user knows what a particular indicator represents.
- **Unit of measure:** this is the metric used to calculate the indicator.
- **Scope:** Defines the range in which the indicator values may be located.
- **Level:** which level in the hierarchy of implementation priorities the indicator belongs to.
- **Frame (detailation):** determines how far the company wants to go by measuring the indicator (eg. production line, plant, individual machine, ...).
- **Measurement type**: absolute or recalculated; the indicator can indicate the total quantity (for example, the total energy consumed in one week in kWh) or the calculated quantity (energy consumed per unit of product / service per week).
- **Period:** the period of tracking and calculating the indicator (eg. week, day, shift).
- **Sources of data:** which data are needed to calculate the indicator, where they are captured / measured and who is responsible for them.
- **Owner:** Each indicator also has its own administrator, who is responsible for its calculation, as well as evaluating and making decisions based on the information obtained.

An example of KPI is presented in Table 2.

Table 2. Example of KPI

KPI DEFINITION	
CONTENT	
Name	Availability
ID	
Description	Availability is a ratio that shows the relation between the actual production time (APT) and the Planned busy time (PBT) for a work unit.
Scope	Work unit, product, time period, product
Formula	Availability = APT / PBT
Unit of measure	%
Range	Min: 0% Max: 100%
Cotext	
Timing	On-demand, periodically
Audience	Supervisor, management
Production methodology	Discrete, batch, continuous
Effect model diagram	See A. 10
Notes	Availability indicates how strongly the capacity of a work unit for the production is used in relation to the available capacity. The term availability is also called degree of utilisation or capacity factor

Source: Johnsson, 2006

It is important that each KPI is defined through a formula, a time model and an effect model. In ISO 22400 the following is mentioned:

- »The formula presents the equation that should be used for deriving the numerical value of the KPI. The equation is an aggregation function of physical measurements, data and/or other key performance indicators.

- The time model is used to visualize information about physical measurements used in the aggregation functions. The time models visualize start/stop time for specific measurements, as well as its relationship to other physical measurements etc.
- The effect model can be seen as a root-cause diagram. Each KPI has its own effect model. The effect model is a picture that highlights the relationship between the KPI and its parameters«.

KPI and their values can be presented in different ways (Zorzut, 2009, p. 27):

- Presentation with absolute value (priority: the indicator has a unit known to the user and directly related to the measured quantity, eg. productivity given by the number of pieces of product at the time of production).
- Linear scale - based on a classical evaluation from 0 to 10 or from 0 to 5. The expected value of the indicator is, for example, rated at 8 and represents 80% of the value of the indicator, so the score 10 corresponds to 100% of the value of the indicator.
- Presentation with a normalized value (usually the indicator is 1 or 100% when one assumes the expected value and it represents a percentage improvement of the indicator relative to the expected value of the indicator).

In standard ISO 22400-2: 2014, 34 KPI for production companies are listed, presented in Table 3.

It is very important that KPI be definable at different levels of company management: at the process, production and business levels (Johnsson, 2006; Zorzut, 2009). The process level means that KPI are installed for individual devices, control loops and process cells. With KPI at the production level, one monitors the production line or the production plant. The business level covers the business of the entire company and is also focused on the success of the business.

KPI on the business level

The most influential framework for measuring organizational performance (KPI on business level) is the balanced score card (BSC) proposed by Kaplan and Norton (2000). The BSC responds to the limits of traditional accounting criteria and seeks to translate the strategy into quantitative criteria that uniquely communicate the organizational vision. Based on the BSC, business performance can be measured (Kaplan & Norton, 2000):

- from a financial point of view, with the following indicators: operating profit, profitability of assets and capital, return on investment, economic value (EVA), revenue growth, and the creation of cash inflows;
- from the point of view of business processes, with the following indicators: market share, share of preservation of old clients, share of new clients acquisition, customer satisfaction, and profitability of clients;
- from the point of view of customers with indicators that include quality, productivity, time cycle, and cost measurement;

from the point of view of learning and growth and employee satisfaction, maintaining employees in the organization, productivity of employees, intellectual property of the organization, market innovations, and the ability of the organization to develop new skills.

Table 3. KPI after ISO 22400

Worker Efficiency	Production process ratio	Finished goods ratio
Allocation Ratio	Actual to planned scrap ratio	Integrated goods ratio
Throughput rate	First pass yield	Production loss ratio
Allocation efficiency	Scrap ratio	Storage and transportation loss ratio
Utilization efficiency	Rework ratio	Other loss ratio
Overall equipment effectiveness index	Fall off ratio	Equipment load ratio
Net equipment effectiveness index	Machine capability index	Mean operating time between failures
Availability	Critical machine capability index	Mean time to failure
Effectiveness	Process capability index	Mean time to restoration
Quality Ratio	Critical process capability index	Corrective maintenance ratio
Setup Rate	Comprehensive energy consumption	
Technical efficiency	Inventory turns	

Source: ISO 22400-2, 2014, p. 34

KPI on production and process levels

KPI systems have been developed to support business management at the highest levels of business. In the last decade, indicators on the process and production level of management - pPI are being implemented. Optimal operation of the management systems can be achieved by automatically collecting process data and mapping these data into pPIs, and by forwarding pPIs to interested users. pPIs show a genuinely useful value when users are able to quickly understand the information contained in the submitted production process data; eg. with these data, pPIs detect problems that arise in production or deviate from the set goals and, with timely action, correct the situation.

It is understood that in organizations there is a link between process-level and business-level indicators. Therefore intermediate direct-level production data is consolidated for each end user separately and is transmitted to it. In a process-oriented approach, the data represent a means to achieve the goal, that is, better implementation of processes, as defined in the process organizational structure.

We now present some examples of indicators at the procedural level (Ruel, 2004; Kinney, 2004; Haji-Valizadeth, 2005; Gerry & Buckbee, 2005, 2006; Gordon, 2006; summarized by Zorzut, 2009, p. 30):

- Variance indicator
- Oscillation indicator
- Usability indicator
- Saturation indicator
- Expert tune indicator
- Exit at the border
- Standard output exit
- Average absolute error
- Crossing the reference value
- Absolute integral error
- Robustness
- Efficiency
- Variability
- Reliability
- Time in emergency mode, etc.

The pPIs on the production level of managing are collected within five groups: safety and the environment, production efficiency, production quality, staffing, and implementation of the plan. The pPIs are as follows in the framework of each group (Zorzut, 2004; Rakar et al., 2004):

- Safety and Environment:
  - Number of accidents per DM
  - Number of alarms
  - Freshwater consumption
  - Production from recycled waste
  - Number of exceedances of limit concentrations of harmful substances

- Efficiency of production:
  - Employee/Infrastructure Efficiency (OEE)
  - Consumption of raw materials and energy
  - Product flow time
  - Efficiency of services
  - Production jam

- Quality of production:
  - Percentage of finished products/raw materials/materials that do not meet quality criteria
  - Waste
  - Quality of services

- Implementation of the plan:
  - Realization of the plan
  - The proportion of delayed production
  - The proportion of production that triggers penalties due to delays
  - The proportion of production that was prematurely realized

- Employees:
  - Lost work days due to injuries and/or illnesses
  - Number of suggestions for improvements and other innovations
  - Number of training sessions per employee
  - Fluctuation on working places/employee performance
  - Realization of goals
  - Degree of absenteeism by location/employee performance

The introduction of Ppi is based on its three-level structure, which allows the organization to use indicators in three groups per levels according to the priority of implementation:

- Level 1 are indicators that are related to regulatory requirements for safety and environmental protection and should be implemented first.
- Level 2 are indicators of quality, tracking the work plan and efficiency.
- Level 3 are indicators that describe different aspects in relation to employees.

Depending on the objectives and importance set, the company begins by defining key or implementing simple indicators and moving towards more complex or less influential indicators. The use of indicators is a continuous process that consists of setting goals and measuring effectiveness in achieving these goals.

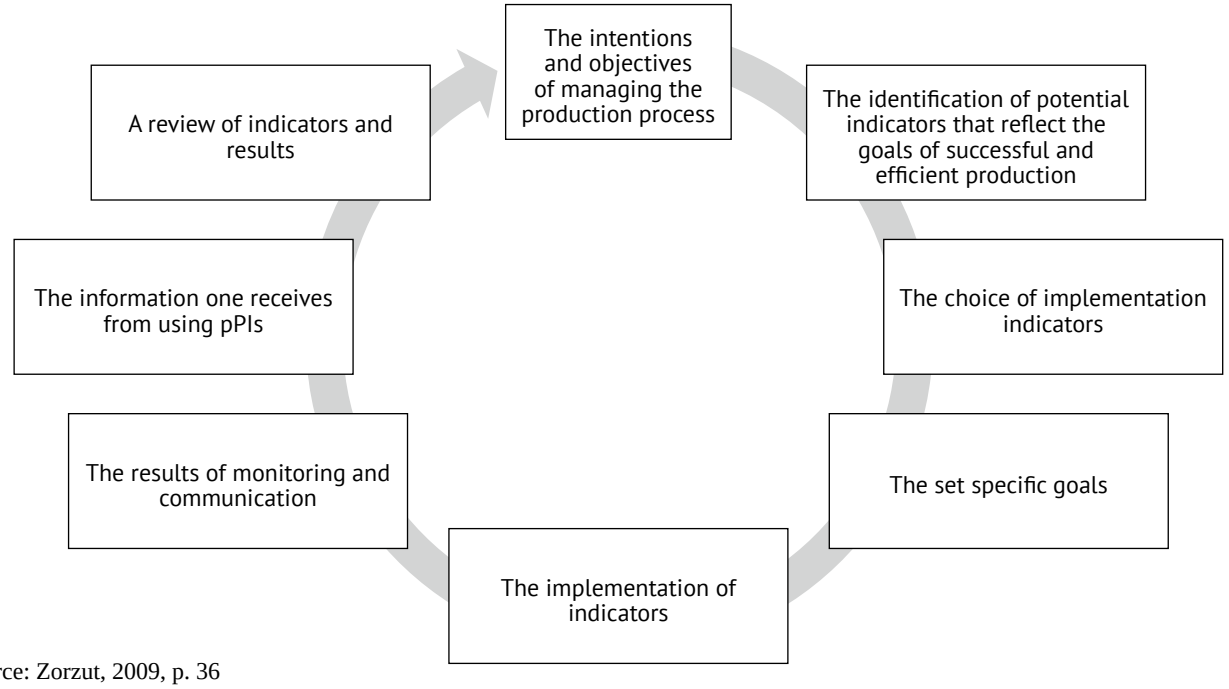
Implementation of Key Indicators in Industry 4.0

The methodology for calculating pPIs (procedural aspect) can be summarized in an 8-step iterative model (Zorzut, 2009):

1. In the first step, one defines the intentions and objectives of managing the production process that are in line with the company's mission. The objectives should relate to the main segments of the production process management and encourage employees to make decisions.
2. The second step involves the identification of potential indicators that reflect the goals of successful and efficient production (as many general indicators are used in the vast majority of manufacturing companies).
3. The third step involves the choice of implementation indicators. In addition to the general indicators at this site, one also considers the possibility of implementing additional and/or omplementary indicators specific to the production of the company. In this process, as many employees as possible should participate. One needs the support of the company's management, the heads of individual plants, and key employees in production.
4. In the fourth step, set goals, specific goals are set. This allows one to check the achievement of goals over a given period of time, increase the interest of the organization's managers, and increase the responsibility of those involved in the project. Achieving the goals does not mean that quality of production is satisfactory and that the goal is achieved, but implies the need to set new goals as a process of continuous progress in all aspects of production.
5. The fifth step is the implementation of indicators. It includes data collection, calculation, evaluation and interpretation of results. It is a time-consuming step that requires the participation of a large number of employees in the company. One must take into account the following points of departure:
   - which type of information system will be used for data management,
   - what kind of software will be used for reporting,
   - which employees will collect which information,
   - how employees will be trained to collect data,
   - how to verify the accuracy of the data.
6. The sixth step contains the results of monitoring and communication. In order to be able to talk about continuous advancement, designers and users of the indicators system should periodically evaluate the results of the use of indicators. It makes sense to establish a system for regular evaluation, interpretation and presentation of results to employees and other stakeholders.
7. Step seven: Action based on the information one receives from using pPIs is a key step. In this step, production managers carry out additional measurements and take measures to ensure the necessary or desired conditions in the production processes, thus demonstrating that the implementation and use of indicators make the process of continuous development of the production process.
8. Step eight contains a review of indicators and results. This step is the basis for setting new targets and indicators.

In Fig. 4, this same process is plotted graphically as already outlined, because it is possible to implement KPIs at any level of governance according to this analogy.

Figure 4: Closed loop model of defining, measuring and developing pPIs



Source: Zorzut, 2009, p. 36

So far, the authors have tried to present the methodology of key indicators, taking into account the characteristics of the 4th Industrial Revolution, to which we will all have to adapt to as soon as possible. The authors are aware that the display was not adapted to individual needs, because without making it an integral part of your production process, it cannot be adapted. However, we have tried to show how this could be provided.

The authors are aware that a comprehensive strategy for the implementation of I4.0 needs to be confirmed by the board of directors. In order not to remain on paper, it needs to be transformed into a program of projects for the implementation of Industry 4.0. This will be followed by an operational plan for:

- Choosing KPIs at different levels of leadership
- Implementation of KPIs
- Modernization of production management models and integrated information support for:
  - Level 4 - production planning systems in the broadest sense (ERP)
  - Level 3 - Production Implementation Systems (MES) and
  - Level 0, 1, 2 - systems for production control (SCADA, PLC)
- Monitoring of the results of all activities.

As the process of improvement is never completed, the implementation of the model of required competences and development activities as well as the individual performance model for employees will be followed up on.

The benefits of KPI implementation include the following:

- a more precise standardization of the work of employees, which would be the basis for achieving a higher level of productivity and establishing a reward system or rewarding the performance of employees, which would have a positive impact on the motivation and commitment of employees;
- more efficient exploitation of production facilities, as one would have precise data on capacity utilization or availability of equipment and/or employees;
- more precise planning of production, which would lead to improvement in the achievement of the agreed product delivery times/equipment, to make it possible to specify the maximum production capacities, which could also be timed;
- identification and elimination of bottlenecks in work and technological processes, which would significantly contribute to the increase in productivity;
- realizing the company‘s default strategy - ie. transition to I4.0, which would be reflected in digitization and automation.

Corporate Social Responsibility in Connection With Key Indicators in Industry 4.0

Corporate social responsibility was also mentioned above, but not covered until now. It might be useful as a starting point using the ISO 26.000 citing seven contents, linked by interdependence and holistic approach, and seven principles supportive of the socially responsible behavior per all contents.

One can suggest that the organization collect opinions on how the seven principles are met in every one of the seven contents, how are they implemented in interdependence rather than in mutual separation, and how much holism is attained on this basis.

We add data about global engagement and commitment of employees, which is crucial also in I4.0. The GEEI - Effectory (2018) found out percentages of the commited employees. They are not satisfactory and show crucial reserves for efficiency and effectiveness to be attained by more CSR:

- North America: 39%
- South America: 43%
- Africa: 35%
- Asia: 25%
- Oceania: 26%
- Europe: 27%
- Global average: 29%.

Criteria on (potentially resulting) business aspects of CSR can be summarised as follows (Mulej et al., 2019):

1. Normal and regular gross earnings;
2. Normal investment funds and measures;
3. EFQM business excellence;
4. Such high managerial and proprietary remuneration that people would not be surprised and wonder ,why they really need it, rather than for showing it off as compensation for the frustration of those with inferior value complexes‘ (Mulej, et al. 2019);
5. A constant circle of excellent business and socially responsible purchasing and sales business partners;
6. Zero legal disputes;
7. The dominance of long-term and broad criteria of business success over short-term and narrow-minded ones;
8. No abuses to affect humans or the natural preconditions for human existence, including high levels of of concern for preventive measures for the health of coworkers and other people throughout the business chain, and broader society;
9. the payment of influential ones on a long-term basis, including payment in shares,
10. Organizational and ownership relations that are as close as possible to the Mondragon Cooperative model;

Table 4. ISO 26.000 and principles of CSR

Principle / Content	Accountability	Transparency	Ethical behavior	Respect for stake-holders' interests	Respect for the rule of law	Respect for international norms	Respect for human rights
Organization, management and governance							
Human rights							
Labor practices							
Environment							
Fair operating practices							
Consumer issues							
Community involvement and development							
Interdependence							
Holism							

Source: authors (with items from ISO 26000 by ISO, 2010, after Mulej et al., 2019)

11. Recruiting for influential jobs modeled on the long-term best companies in the world, as identified by Collins and Porras in books on ‚visionary companies' and ‚the path from average to excellent', so that in practice one uses;
12. Creech's model of the five pillars of total quality (perfect products, perfect processes, managing by example, and commitment, all four being linked by perfect organization), and
13. creative collaboration methods such as ‚6 Thinking Hats' by E. De Bono and Nastja Mulej, M. Mulej's USOMID, their synergy, and the like;
14. Renewal or even innovation of business according to the model in the Horus Questionnaire (by IRDO, see www.irdo.si), and
15. Payment of wages according to the Mulej's innovative business model, whereby
16. The state creates and maintains the Prof. Florida's 3T model on rise of the creative class, with invitational conditions making the regions innovative (due to synergy of tolerance, inviting talents and making sense of technology investment).

Concluding Remarks

The authors present the methodology of key indicators, taking into account the characteristics of the 4th Industrial Revolution, to which we will all have to adapt as soon as possible. The authors are aware that the display was not adapted to individual needs, because it is not possible, if one does not become an integral part of your production process. However, the authors tried to show how this could be provided.

The authors are aware that a comprehensive strategy for the implementation of Industry 4.0 needs to be confirmed by the board of directors. In order not to remain on paper, the strategy needs to be transformed into a program of projects for the implementation of Industry 4.0. This will be followed by an operational plan for:

- Choosing KPIs at different levels of management
- Implementation of KPIs
- Modernization of production management models and holistic and integrated information support for:
  - Level 4 - production planning systems in the broadest sense (ERP)

  - Level 3 - Production Implementation Systems (MES) and
  - Level 0, 1, 2 - systems for production control (SCADA, PLC)
- Monitoring the results of all activities.

As the process of improvement is never completed, the implementation of the model of required competences and development activities as well as the individual performance model for employees will be the next step.

The benefits of KPI implementation are at least the following ones:

- A more precise standardization of the work of employees, which would be the basis for achieving a higher level of productivity and establishing a reward system or rewarding the performance of employees, which would have a positive impact on the motivation and commitment of employees;
- More efficient exploitation of production facilities, as one would have precise data on capacity utilization or availability of equipment;
- More precise planning of production, which would lead to improvement in the achievement of the agreed delivery times / equipment of the product, as it would be possible to specify the maximum production capacities, which could also be timed;
- Identification and elimination of bottlenecks in work and technological processes, which would significantly contribute to the increase in productivity;
- Realizing the company's default strategy - ie. transition to Industry 4.0, which would be reflected in digitization and automation.

KPI may help organizations adopt the I4.0 model, but the human and humane aspects may not be neglected. Success of I4.0 depends critically on employees and other business partners, not only on equipment. The latter seems to be found more important by many authors and managers with more of the engineering than humanistic background. Equipment is crucial, but is it designed, produced and used by humans. Hence, CSR is crucial in I4.0 conditions.

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Ključni kazalniki uspešnosti in Industrija 4.0 – družbeno odgovorna perspektiva

Izvleček

Glavni cilj prispevka je predstaviti vlogo in pomen ključnih kazalnikov uspešnosti v okviru implementacije industrije 4.0. Ključni kazalniki uspešnosti so predstavljeni kot temeljno izhodišče za implementacijo industrije 4.0 v organizacijsko prakso, saj predstavljajo ključni input za potrebne podatke v digitalizirani organizaciji. V tem okviru prispevek najprej izpostavi nekatere bistvene značilnosti „Industrije 4.0“, čemur sledi metodologija ključnih kazalnikov uspešnosti (KPI). Nato v prispevku opisujemo predlagano metodologijo za implementacijo KPI-jev v okviru Industrije 4.0 v organizacijah. Prispevek nadalje izpostavlja povezavo med družbeno odgovornostjo in KPI-ji v okviru Industrije 4.0. Prispevek prav tako izpostavlja predloge za prakso, omejitve prispevka in predloge za nadaljnje raziskovanje.

Ključne besede: Industrija 4.0, ključni kazalniki uspešnosti (KPI), družbena odgovornost

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Competency Management, Coordination and Responsibility in Slovenia

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Abstract

The purpose of this article is to highlight the importance of investments into competencies. The identification of competencies should belong to the strategic goals of any socially responsible society. The right competencies are a crucial precondition for a functioning labour market in times of digitalisation and technological changes: for good economic performance as well as to ensure lifelong productive and inclusive individuals. Relevant skills and competencies should respond to labour market needs as well as to economic requirements. The approach to this study is linked to the practical deficiencies of ineffective competency management in Slovenia and its consequences. The methodology combines study of theoretical models and specific skill framework in selected countries with chosen policies. The findings confirm that educational paths in Slovenia are not aligned with the economy requirements. Competencies do not correspond to actual industrial policy priorities. The article identifies the reality of competency policy in Slovenia and governance gaps in comparison with EU and OECD countries. It focuses on foreseen skills challenges and skills forecasting needs. The article offers solutions and policies for better skills matching and further reflections on more co-ordination and governance between educational policies and competency requirements in the economy. One limitation of this study is the variety of policies in countries, hindering the transferability. Nevertheless, the article tackles skill and competency challenges, which are common in most of the countries and require actions.

Keywords: competencies, skill mismatches, skill gap, industrial policy, forecasting

Introduction

Skills and competencies are becoming the essential driver of productivity and competitiveness in companies. The term "competencies" is broader than "skills." While skills are specific to a task, competencies incorporate a set of skills with abilities and knowledge. For the purpose of this paper, both terms are used according to the context. Employers require qualified and flexible workers who can cope with fast changes in the working environment, which can contribute to the company's success and face global pressures with aplomb. To achieve these goals, adequate policies and effective cooperation and governance among relevant bodies should lead from the right educational pathways towards work efficiency and job matching.

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The reality shows substantial skills and competency mismatching and deficiencies across Europe. According to the European Commission, 70 million Europeans lack adequate reading and writing skills, and 40% of European employers have difficulties finding people with the right skills (EC, 2016a). The situation varies by country, but requirements for the right skills and competencies are increasing across the board. According to the OECD Skills Strategy Diagnostic Report (2017), many recent graduates in Slovenia lack strong cognitive and social-emotional skills, as measured by the PIAAC[1] survey. But it is not only young people; one can observe skills deficiencies in all ages. One third of 16-to 65 years old in Slovenia (almost 400,000 adults) have low levels of literacy and/or numeracy and most of them are not interested in adult learning. Research confirms that low-educated adults are three times more likely to be low-skilled (27%) than those who are highly educated (9%) (CEDEFOP, 2017). In Slovenia, data show that while only 13% of Slovenia's adult population has not completed upper secondary educaiton, they account for 40% of low-skilled adults (OECD, 2017). The knowledge society is still distant. The technological progress leads into automatisation of jobs: according to OECD, about 26% of workers in Slovenia face a high risk of seeing their jobs automated; the EU average is lower at 14% (Nedelkoska & Qintini, 2018).

The rising awareness of investments in skills and competencies should be intensified and pronounced more loudly. It is important to know what information is needed for different users to be successfully included into the skills agenda. Active inclusion of all the relevant stakeholders, which can influence the skills challenges and offer educational guidelines, should become the norm. This fact demands closer cooperation, governance and coordination among educational and labour market institutions on one hand and the economy on the other. It is an important tool to increase productivity, which leads to more effectively allocated human talent to jobs (OECD, 2015). The complexity of policy decisions deteriorates the variety of different stakeholders involved in skills investments. There are 20 ministries and 212 municipalities in Slovenia with different legislative acts and responsibilities, lacking systematic and appropriate mechanism for skills development costs sharing (OECD, 2018).

The methodology for this article includes theoretical models and theories, together with existing good practices in time and their results. The article starts with the explanation of importance of investing in skills and competencies, continues with advantage of skills and competency recognition for individuals, companies, and society, and concludes with findings and conclusions. The goal of the article is to search for reasons why the skills agenda and adequate competency levels in Slovenia are not efficient and do not enable adequate matching. The research question focuses on possible improvements of identified gaps and problems with skills use to ensure well-functioning labour market.

Recognizing the Importance of Skills and Competencies

Neoclassical models imply that a one-off increase in the stock of human capital leads to a one-off increase in productivity growth, while endogenous models suggest that the same one-off increase in human capital can lead to a permanent increase in productivity growth. In the short term, both models produce similar results, each dependent on their specifications, but in the long term the endogenous models imply significantly higher returns on investment in human capital (Wilson and Briscoe, 2004). Regardless of the specific models adopted, there is strong evidence that higher education increases productivity and higher levels of national growth. Furthermore, empirical research in recent years has shown that if education is measured by the skills learned, the education of a population is very closely linked to its nation's long-term growth rate (CEDEFOP, 2017).

The theoretical background of measuring the impact of education on economic growth developed two discrete approaches. The first, the theoretical model, was developed in 1950s and based on microeconomic theory of human capital. The second, the endogenous growth model, stressed the role of education and diffusing new technologies and new ideas (CEDEFOP, 2017). The role of human capital in relation to economic growth gained importance with accelerated world competitiveness. The estimates suggest that a 1% increase in average share of working-age population enrolled in secondary education during 1960-1985 translated into a 0.7% increase in GDP per working-age person (Mankiw et al., 1992). Measurements by Kyriacou (1991) did not find significant impact of growth in human capital on economic growth but found that a 1% increase in the stock of human capital increases per capita GDP growth between 12% and 17%. Education and competencies need lifelong upgrading.

In the knowledge economy, human capital is the main driver of innovation and productivity. Skills investments may generate positive externalities and spill overs both within organisations and the economy (CEDEFOP, 2014c) Investing in skills and competencies generates economic growth and technological progress, improves individuals'

[1] Survey of Adult Skills (http://www.oecd.org/skills/piaac/)

lives, and enables well-being in societies. Investment in human capital affects economic growth through innovation process; investment in education leads to a more skilled and competent population, which is able to generate and adopt new ideas that spur innovation and technological progress (Heinrich & Hildebrand, 2005). Investments into skills and competencies therefore result not only in benefits for the individual, but also improves productivity and competitiveness far more than increase in wages.

Skills and competencies should be aligned with labour market requirements. Since 2015, Slovenia have adopted many important strategic documents, among them the National Development Strategy, the Industrial Policy, Slovenia's Smart Specialisation Strategy and the Vision of Slovenia 2050. However, the mentioned documents are not synchronised and do not prioritise the need for policy synergies linked to human capital as the important knowledge-based capital. The Resolution on the National Plan for Adult Education 2013-2020 and the National Higher Education programme 2011-2020 are additional documents, focused mostly on educational reforms. According to the OECD, the innovation performance of universities and public research institutions in Slovenia is mixed; despite R&D, expenditures are close to the OECD average, investments in research have not translated into tangible output. Furthermore, there is a concentration of business R&D spending in a small number of large firms, and links among Slovenia's research institutes are not strong (OECD, 2017). The optimistic step forward presents the Research and Innovation Strategy of Slovenia (2011-2020), aimed at modernising the Slovene innovation system. The OECD also stresses that the entrepreneurial culture in Slovenia is limited. More effective, transparent, and horizontal oversight offers the Slovenia's Adult Education Master Plan 2013-2020, confirming the goals of adult learning system in Slovenia.

Nevertheless, the lack of systematic approach towards the skills agenda in Slovenia is visible in the school curricula, causing sub-optimal entrepreneurship and innovation performances in companies. According to the OECD study, information about the personal, employment and social outcomes achieved by different adult-learning providers and programmes is almost non-existent in Slovenia (OECD, 2018). To sum up, there are a lot of fragmented strategic documents available, but hardly any common minimum denominator or policy indicating human capital as a strategic national asset.

In contrast to most Western European countries, there are only limited comprehensive adult learning programmes in Slovenia and only a few are modular or credit-based. Experiences from the Slovene Public Employment Service (PES) confirm that work-based learning and on-the job training are far more popular and successful programmes for the adult population. Motivation is another challenge. Tax deductions for investments in skills for individuals and firms are used in most advanced countries. Tax deductions for skills investments for individuals were abolished in Slovenia; re-introduction would be welcome in the context of an increased need for skills upgrading. Furthermore, the instability of public funding for adult learning over the last decade has threatened the sector's stability to achieve national goals for adult learning (OECD, 2018).

Public investments into education and life-long learning are essential to ensure that workers have the capacity to learn new skills and adapt to changing technologies (OECD, 2015). In general, Slovenia's public administration may lack the incentives and capacity to take a whole-of-government approach to skills policy (OECD, 2017). On the national level, or at least at the declarative level, all the decisions about or changes to adult education should be discussed at the Economic and Social Council to streamline the skills policy. Adult learning has an important role in national policy. Countries with advanced adult learning systems understand their usefulness in supporting economic and social adjustment processes (Desjardins, 2017).

The involvement of local governments in Slovenia, which are also responsible for adult education, depends on individual municipalities' ambitions and many times lack the administrative capacity for sufficient skills policy implementation and adequate competency level at the local level. The local environment knows the needs of the local economy; thus the significant ignorance and neglect of the skills and competencies base importance for the economy at the local level is worrisome.

The article focuses on the impact of skills and competencies and possible improvements of skills and competencies in Slovenia for the individuals, companies, and the government regarding policy gaps and policy actions. A recent OECD study on skills in Slovenia and relevant research and working papers highlighted the most relevant challenges in the field of skills and competencies to be improved.

Competencies and benefits for individuals

Lifelong learning and permanent investments into skills and competencies are the right and the responsibility of every individual capable of contributing to the labour market. Innovations and competitive advantage in technologies increasingly arise from the excellence of skills and competencies. Workers in Slovenia sometimes lack a sense of personal

responsibility for identifying gaps in their own skills and upgrading them throughout their lives. Rejecting one's own skills and competency progress is not a socially responsible act and should not be tolerated. Additionally, modern (e-)socialites require e-literacy, which will be soon the significant guarantee of social inclusion in both working and civil life. On the other hand, employers seldom have deeper insight into the validated or invisible skills and competencies of employees. Not all employers support their own initiatives for skills upgrading, and the transparency of available skills and competencies at company level is often missing. To complicate matters further, Slovenia's main portal for information for prospective adult learning covers only 253 of more than 500 adult education providers, making the choice opaque and unreliable (OECD, 2018).

According to the OECD Survey of Adult Skills (PIAAC), about one-third of workers in OECD countries are over- or under-qualified for their jobs, a seriously inefficient allocation of resources (EC, 2016c). The 2012 Flash barometer (354) stresses that only half of the EU population above 15 agree that their school education helped them to develop a sense of initiative and a sort of entrepreneurial attitude (EC, 2012). Wrong or inadequate skills diminish the multiplicative effects of schooling or training. According to the CEDEFOP study, adults in employment who do not engage in substantial upskilling or reskilling for five or more years run the risk of becoming locked into particular ways of working (CEDEFOP, 2014b). The PIAAC further reveals that the use of reading skills explains a considerable share (26%) of variation in labour productivity across countries' participation in the programme (OECD, 2016a). Therefore, the benefit of paying more attention to skills should not be underappreciated. Career counsellors should play a prominent role in promoting lifelong learning promotion and raising motivation and should direct students towards required skills and competencies in the labour market.

Study of Barro (1991) suggests that a 1% increase in skills is associated with a 0.3% increase in average labour productivity and with a 0.365% increase when the model is extended to take into account the potential role of skills in assisting productivity follower countries catch up with countries on or near the frontier. A one-year increase in average education is associated with a 3 to 6% increase in the level of GDP per capita and a 1% increase in school enrolment is associated with an increase in GDP per capita growth of between 1% and 3% (Sianesi, 2003). Sadly, any increase in competencies in Slovenia is often not rewarded and results in decreased motivation to increase one's skills and competencies.

Another factor influencing productivity is ageing. Companies are often not aware that ageing of the population hinders productivity growth due to a lower participation rate. Therefore, investing into the available working-age population is important. Taking into account the high share of the EU population, including low-skilled, inactive, and old people, into lifelong learning should be a priority for companies. As there is no information on individuals' expenditure on adult learning available in Slovenia (OECD, 2018), it is difficult to assess the reason for low participation in adult education for certain target groups in the labour market. Nor are available information or evaluations on employment or social outcomes of individuals due to inclusion in adult education (OECD, 2018).

Assessment and validation of existing skills and competencies are important for use and rewarding of human capital in an era of a declining working-age population through Europe. Only by recognising skills and competencies in employees can governance evaluate possible positive outcomes arising from available human capital, recruiting and retaining people with adequate skills and competencies.

Do companies appreciate investments into competencies?

The persisting entrepreneurial conviction of skills investments as costs is not justified. Employers should recognise that the added value of the company depends on the skills and competencies of their employees. As 70 million Europeans lack adequate reading and writing skills (EC, 2016a), the number also indicates productivity loss due to inadequate investments into this group of workers. In the EU, 23,4% of the population in the 25-64 age bracket do not have an upper secondary education, and only 29.9% hold a tertiary degree (EC, 2016c). Fast technological changes require ICT skills; almost 50% of the EU population lacks digital skills and 20% of them do not have digital skills at all (EC, 2016a). The shift to service sectors is relying more and more on the ICT and e-trade, and elimination of digital gaps is the mandatory tool for business success. That is why the Commission has launched an additional initiative in 2016, the Digital Skills and Jobs Coalition.

EU governments and social partners consider the current lack of adaptable skills to be one of most important challenges in the years to come (EC, 2018). The aforementioned concern is driven in particular by digital-skills mismatches in the labour market. In most EU Member States, it is expected that suitable candidates for vacant positions will become increasingly scarce (EUROFOUND, 2016). The digital skills gap provides a strong impetus for joint action by social partners. Trade unions want to ensure that no one is left behind: digitalisation should avoid reinforcing the uneven distribution of wealth (ETUC, 2016).

Employer organisations approach the challenge from a different angle. They see the adaptation of skills as essential for meeting the needs of enterprises and of the economy as a whole (BusinessEurope, 2015).

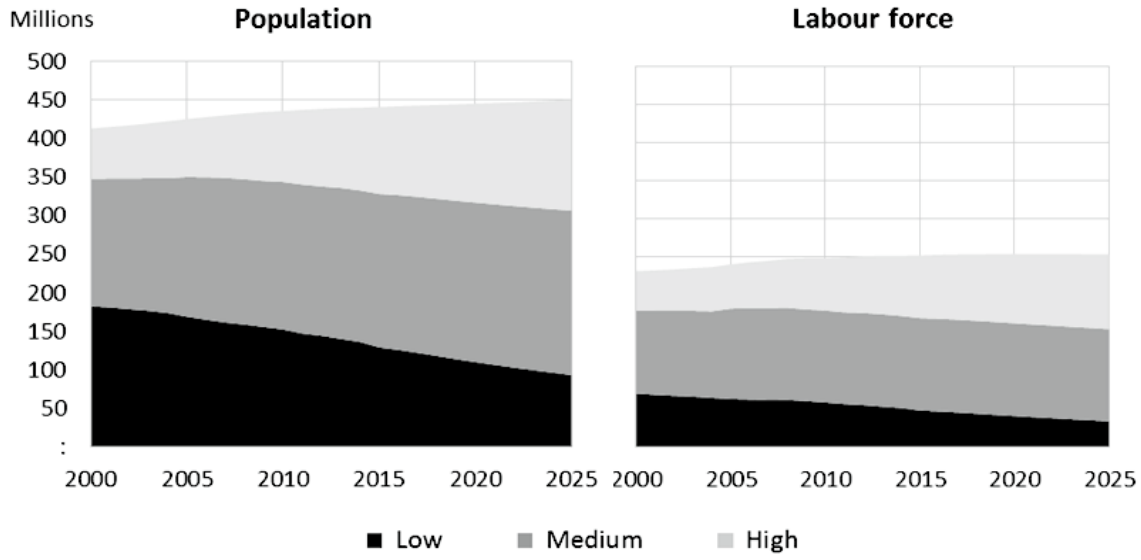
In reality, a high share of employers does not have a long-term vision of investing in their own employees and instead postponing any reflection of future skills gaps or mismatches. It is worrisome that according to evaluations, 91% of adult participation in non-formal education and training in Slovenia is non-publicly recognised programmes (Taštanoska, 2017). The aforementioned high number points to the difficulty to prove one has gained new skills and competencies. SMEs as prevailing companies in Slovenia lack skills and competency management, adequate funds for investments into skills and capacity building and consequently lag behind larger enterprises in terms of productivity and human capital stock. According to BusinessEurope, financial incentives and other forms of investments pooling can also play a positive role, particularly for SMEs, which struggle to find resources and expertise needed to embrace digitalisation (BusinessEurope, 2019). Despite the Employment Relationship Act (2013), stipulating that employer support for adult learning should be specified in a contract or collective agreement, employers' generosity differs considerably between agreements (OECD, 2018).

As discussed in the EC's annual publication (EC, 2016), social partners at the national level can play a crucial role in skills upgrading throughout working lives. Employer and worker organisations are well placed to recognise evolving skills needs and design training programmes that match these needs. A number of competence centres have been developed in Slovenia with the support of the European Social Fund (ESF) in order to boost human resource development. Enterprises, often in emerging sectors such as sustainable construction and the circular economy, set up competence centres to upgrade existing skills and develop new ones in cooperation with other organisations in the sector such as employer and business associations (EC, 2016).

Fluctuations and migrations can indicate mismatches as undervalued and not recognised skills and competencies that individuals possess. Skills acquired through informal and/or non-formal education are mostly not used or rewarded at work, which contributes to "official" skills mismatches. Trade unions and employers' organisations often do not provide (non-formal) learning at all (AES, 2016). In this context, one can include also transversal skills, which increase with experiences and work transitions. The "culture of lifelong learning", as defined by the OECD (2017) should be promoted in a way that recognizes human-capital investments as an integral part of management plans by "putting skills into effective use". The reduction of mismatches in OECD countries could increase productivity between 2% and 10% (OECD, 2015). This is "the language" that employers understand. The interesting trend of declining labour force in time is seen in Figure 1.

Obviously, there is also a need for more skilled people in the context of the declining workforce. In Slovenia, more flexible forms of investments in skills and competencies should be applied, and the tax deduction for skills investments for companies should be reintroduced. Modular

Figure 1. Population (left) and labour force (right) by qualification in EU-28+



Source: Cedefop skills forecasts (2016).

education should be promoted more intensively. It is worrisome that only 25% of adults in Slovenia looking for information on learning possibilities consulted their employers (Ivančič, Špolar & Radovan, 2010). Last but not least the high taxation and low returns from investments in human capital deter highly skilled individuals from investing in skills and competencies and reduce motivation for more innovative and productive contributions to the working process. The problem of the tax system and consequently relative low earning potential of highly skilled people in Slovenia is recognised also by the OECD (2017). On the other side, low-skilled and other vulnerable groups often face financial barriers, preventing them from further participating in skills upgrading. According to OECD, workers in Slovene SMEs are just as likely to participate in adult learning as workers in larger companies, but workers with temporary contracts face a relatively large participation gap compared to other countries (OECD, 2019a). Social partners should discuss these challenges more often and more sincerely. Better skills and competency management, adequate allocation of available funds, based on performance-based financing would enable clearer distinctions among training providers. In this context, BusinessEurope calls on the European Commission and ESF managing authority in the Member States to design European and national initiatives aimed at supporting investment in skills with social partners at both cross-industry and sectoral levels. Involving social partners at an early stage will be crucial to avoiding the use of resources in a way that fails to meet the real needs of employers and workers across Europe (BusinessEurope, 2019).

The High-performance Work Practices (HPWP), which includes organisational and management practices[2] in companies, is rarely used in Slovenia and accounts only 23% of all jobs in Slovenia in comparison with other countries (mostly Scandinavia) (OECD, 2017). The recent trend of emigration in Slovenia is partially due to the underestimation of human capital and subsequent undercompensation. According to the OECD, of the 13,000 people who emigrated from Slovenia in 2015, over 20% held a tertiary degree (OECD, 2017).

In general, companies often forget that higher levels of cognitive skills area associated with a number of positive economic and social outcomes for individuals and society (OECD, 2017). There is obviously room for significant productivity gains. It is interesting that companies recognise the importance of new technology for better performance, but do not recognise investments in skills and competencies for better productivity. The OECD PAL dashboard data shows that on average (across available OECD countries), 75% of enterprises with at least ten employees provide training opportunities to their employees, ranging from 99% in Norway to 22% in Greece. However, training is provided to more than 50% of the workforce in only 40% of enterprises. The aforementioned dashboard includes an indicator of firms' investment in training (expressed as a share of total investments), using the EIB Investment survey available for European countries. In 2016, training represented 9.7% of total firms' investments on average across European OECD countries, with shares as high as 16% in France and Luxembourg, but less than 6% in the Czech Republic, Hungary, and Slovenia. Nor are they looking ahead; only two in three firms assess their future skill needs. Another problem arises from the fact that employers use qualifications as a proxy for skills and this may lead to placing people in the wrong job; on average, a quarter of workers in OECD countries report a mismatch between their existing skills and those required for their job (OECD, 2019b). Adult learning typically receives less funding compared to other education areas (OECD, 2019). As the Commission's analytical paper states, the issue of polarisation could greatly affect the relationship between skills and economic growth (EC, 2016c).

Human Capital and National Returns

The quality of training and educating alone does not mean that it responds to the economy's needs. Cooperation between education and business should be deepened, strategies and reforms should be adopted in consensus with all stakeholders, who are included in the skills formation and skills use process (competencies building). National industrial policy should play an important role as a framework for needed adaptations or revisions of educational and training programmes and modules. Additionally, programmes or reforms require a systematic approach and should not change too quickly, so as to enable reliable evaluation of implemented changes for further programmes development or necessary revisions of the programmes. As in many countries, adult learning does not systematically prepare adults for the changing skills demands of the labour market, so the OECD has recently developed a new dashboard on Priorities on Adult Learning (PAL). It is facilitating comparisons on future-readiness of adult-learning systems across OECD countries (OECD, 2019a). According to PAL, Slovenia ranks lowest in urgency of skills challenges and the financial constraints of adult learning but is among the best performers in inclusiveness and alignment with skills needs. Furthermore, available estimates for selected OECD countries (2009) show that the state, on average, bears the smallest

[2] HPWP includes organisational factors (teamwork, autonomy, mentoring, job rotation…) and management practices (work flexibility, incentive pay, training practice…)

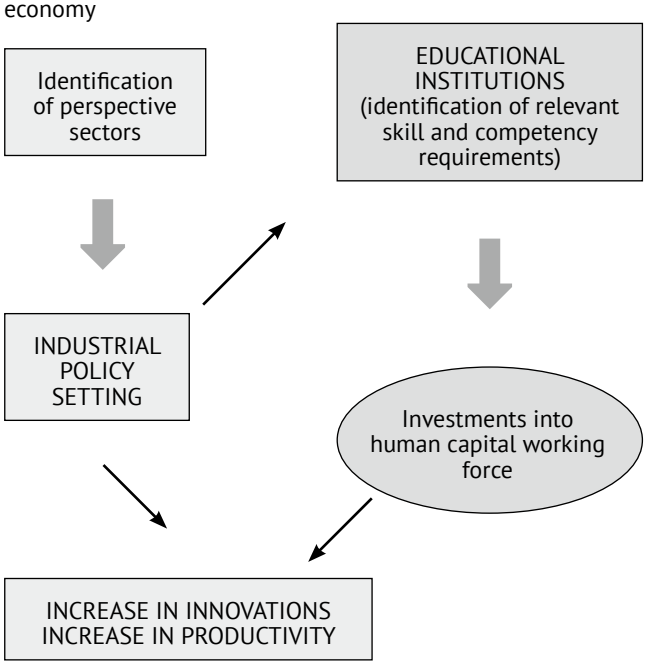
share of the financial burden (22.1% of total spending on adult learning on average), followed by individuals (24.7%). The largest share of adult learning costs rests with employers (44.7%) (FiBS and DIE, 2013). Last but not least, higher competencies lead to higher productivity, higher wages, and consequently higher tax revenues for the government. Therefore, governments should understand that investing in skills and competencies brings higher added value and requires equitable cost sharing among the individual worker, companies, and the government.

The quality of skills matters as well, of course. Lack of visibility of comprehensive educational outcomes hinders quality ranking to guide individuals towards high quality educational and training institutions. Information on skills upgrading opportunities are fragmented: only 9% of adults with low educational attainment in Slovenia have searched for information on learning opportunities (14% in the EU-28) (EC, 2015). This fact is especially worrisome, as half of Slovenia's unemployed adults have been out of work for more than one year, which is one of the highest long-term unemployment rates in the OECD (OECD, 2016c).

Information on employability outcomes would enable higher competitiveness in educational and training choices. Another instrument is the already mentioned performance-based financing of training providers. It would provide information on comparability and possible higher economic and social returns for individuals, for companies, and at the national level. The coordination among relevant ministries and educational institutions in Slovenia is missing; the increase of the "working in silos" phenomenon is visible in weaker economic performance and lower worker productivity. No coordinated approach towards skills and competency anticipation and matching, financing and balanced taxing human capital outcomes is taking place in Slovenia. The regional level is often excluded from suggestions, but skills and competencies are desperately needed at regional or local level. This is unacceptable, taking into account the fact that more than 90% of companies in Slovenia are SMEs. It is the European Social Fund (ESF), which contributes a significant share of funding to companies. However, as the majority of funding into adult learning system is funded by ESF (77% of expenditure at the Ministry of Labour, 72% at the Ministry of Education), the sustainability of funding is non-sustainable and financially vulnerable in the next Financial perspective. To decrease the risk of ESF funding on the national level, ESF should be distributed among governments, companies and individuals by different sharing formulae.

Many EU documents highlight the importance of skills and competencies. The European Pillar of Social Rights (adopted in 2016) acknowledged the significance of investments into skills. The New Skills Agenda as the leading initiative in this context is stressing that one of Commission's priorities should be focused on i) improving the quality and relevance of skills formation, ii), making skills and qualifications more visible and comparable and iii) improving skills intelligence and information for better career choice. Skills development and relevant support are highlighted also in the "ET2020"[3] and "Key Competencies"[4] Frameworks. Promotion of skills should be holistic; it should be promoted as a national and a European priority. The first result of the Commission's reflection in this context is a launch of the Blueprint for Sectoral Cooperation and Skills, offering long-term vision on skills needs, along the CEDEFOP forecasting publications. To reach the goal of sustainability and right direction of investments into skills and competencies, interrelations between skills, competencies and economy should be enforced, as seen in Figure 2 below.

Figure 2. Interrelations between skills, competencies and economy



CEDEFOP states that about 85% of all job openings will arise from the need to replace workers leaving the occupation due to retirement or other reasons for moving into inactivity.

[3] Strategic framework–Education&Training2020, (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aef0016, extracted August 8, 2018).

[4] Council Recommendation on Key Competences for Lifelong Learning https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_9009_2018_INIT&from=EN, extracted August 8, 2018).The European Reference Framework sets out eight key competencies: Communication in the mother tongue; Communication in foreign languages; Mathematical competency and basic competencies in science and technology; Digital competency; Learning to learn; Social and civic competencies and Sense of initiative and entrepreneurship.

Between now and 2025, even the share of those working in elementary occupations with low qualifications will reduce from 44% to 33%, while the share of those with high qualifications working in occupations demanding typically lower levels of skills will grow from 8% to 14%. Employment of those highly qualified across Europe in all occupations in the next 10 years will increase from 32% to 38% (CEDEFOP, 2016). Research by Elliot S. (2018) shows, that almost 40% of the workforce in Slovenia is vulnerable to displacement by computer technology (Elliot, 2018). On the other hand, use of digital skills increases employment opportunities and opens new markets, including global ones, if used properly. If Slovenia will not invest in the ICT and other emerging skills, it might lag behind and decrease productivity and the market scope. A socially responsible spillover of skills and competencies is even more important to support R&D not only in leading firms, but also in laggards. Inter-ministerial cooperation matters as well. Many civil servants may lack the skills and experience required for effective inter-ministerial co-ordination for adult learning (Drofenik, 2013).

Adequate funding without a basis in previous evaluations does not guarantee correlation between funding, participation or productivity outcomes. As confirmed by Desjardins, at the school level, funding levels are positively associated with students' outcomes up to a certain point. The OECD Programme for International Student Assessment (PISA) data show that in countries with cumulative expenditure per student below USD50,000 annually, the effect of spending is significantly associated with higher PISA scores. However, for countries with cumulative expenditure above USD50,000, like Slovenia and most other OECD countries, the effect of spending is not significant (Desjardins, 2018).

According to the OECD study on Slovenia's skills strategy guidance, a shared understanding of challenges, opportunities and priorities among relevant stakeholders should include i) information on adult-learning activities, expenditures and outcomes, (comprehensive information and accessible information); ii) information on learning opportunities, including potential benefits; and iii) information needs with reliable information about current and future skills requirements. Regarding skills forecasting, Slovenia mostly relies only on employer surveys, so there is still an ambiguity among institution, which one – perhaps an independent one - should be responsible for assessing and anticipating skills needs in Slovenia (OECD, 2018).

Business and educational institutions should follow the same goal-higher level of innovations, increase in productivity, and general welfare for all. To achieve the aforementioned goal at the national and European levels, a clear vision of the future economic development should be determined. Only then can the right skills and gaps be identified and policies revised and improved. On the other hand, if data on the specifics of available stock of human capital is given, the mentioned knowledge-based capital can determine economic future and the most competitive sectors. However, it is not possible to develop wise and reliable policies, taking into account only isolated economic or isolated educational policies. Finally, research confirm that participation in education has range of non-market benefits that extend far broader into the personal life and the community (CEDEFOP, 2017).

Future Steps to Be Reconsidered

Skills and competencies matter, now more than ever. It is the socially responsible thing to share the burden of investments into skills and competencies among individuals, companies and the government. The reality is different. Business usually recognises only fast and visible results and considers any other investments to be costs. Governments neglect skills and competencies as national assets. Business should become active actors in the formation and identification of skills and skills needs. Companies should collaborate hand in hand with other institutions and advocate for educational modernisation. Governments should become socially responsible and mature. There should be higher political level of commitment to the skills agenda in discussions of future national development. Skills and competencies development and direction of development in Slovenia should be agreed upon at the highest political level to serve defined socio-economic goals. To sum up, governance, coordination, and cooperation are key actions to improve the skills and competency performance in Slovenia in general.

Skills and competencies belong to the invisible capital (assets) and as such should be appreciated, more visible, and more integrally part of the socially responsible management practice at the company level. Skills and competencies are becoming the comparative advantage of individuals. Lower investments in skills of older people is in contradiction with a prolonged working age worldwide. Monitoring skills and competencies should spread through the whole life cycle due to inevitable penetration of e-society into daily life. Workers with low skills and a lack of competencies should not be afraid to express their skill needs to update their gaps. In this context, the inclusion of people over 65 years into the PIAAC Study might highlight the life-long functional literary rate and participation in the life-long learning for people over 65. This category of people is excluded from the PIAAC Study, reducing the insight into the skills problem of elderly people. Lifelong investments in skills to enable equal access to modern technology and life-style to all enriches society as a whole and increases the social inclusion. Adult learning is also positively associated with

health (Vera-Toscano, Rodruigues & Costa, 2017), leading to lower social costs.

Skills and competencies should pay off. There is a need for coordinated efforts to motivate individuals into skills formation. Skills policies in Slovenia should incorporate quality education programmes and adequate economic policies, which do not tax skills remuneration over-proportionally.

A bigger effect could be achieved by taxing neglected shared responsibility of investments into skills and competencies. No compulsory annual reporting on skills investments is required. The introduction of reporting on skills activities should be welcomed in annual reports within non-financial reporting. Higher contributions from annual revenues might be directed towards a "skills fund" for (re)-training, if reports would not prove investments in skills of employees. Along these lines, tax exemptions for individuals should be reintroduced in Slovenia, as is the practice of many developed and successful countries. Optionally, lending conditions to businesses might include clauses on obligatory investments into skills and competencies as a condition for preferential rates.

Taking into account EU-wide skills mismatches, transparency and recognition of skills and competencies should be provided, also by raising awareness about the skills and competencies importance and added value it brings. Identification of relevant skills and the use of acquired skills is becoming an important task for every company as well as for the national context. The important element for better skills matching presents adequate information and access to skills providers. Identification and provision of required skills and competencies in Slovenia should become the responsibility and the priority of companies as well. The established Skills Council in the UK and some other countries can serve as templates for good practices.

EU funds coming to Slovenia should be used more efficiently. Europe is recognising the added value of skills, competencies and investments in human capital, allocating a significant share of EU funds for improving and developing skills and competencies necessary in the labour market. The European Social Fund supports over 27 billion EUR for investments into skills, education, training and lifelong learning during the 2014-2020 programming period (EC, 2016c). Slovenia is facing the instability of public funding to achieve national skills goals and need to "develop the culture of co-operation" (OECD, 2018). More horizontal and vertical cooperation would improve skills and competency knowledge as well as capacities needs to reach available and affordable solutions. Each sector should identify its challenges and solutions responsibilities. It is important to mention that the precondition for successful governance is establishment of reliable skills forecasting in Slovenia.

By going in this direction, coherence of ministries and levels of governments in Slovenia would be ensured by minimising overlaps in adult learning services, along with effectively sharing responsibilities for promoting and funding adult-learning (OECD, 2018). The local level of governance can be successful in implementing actions to reduce skills gaps identified in the local environment and performed by relevant institutions. On the other side, the high number of municipalities does not allow for full exploitation of the existing knowledge on skills needs or requirements for any improvements on the national level. Slovenia should effectively tailor its national policies to local/regional needs and improve inter-cooperation among municipalities as partnerships. In fact, some municipalities provide no funding for adult education at all (OECD, 2018). Improvements in the skills policy positively affect employment, social, welfare as well as general economic situation and development in Slovenia. The mentioned fact has been confirmed by two studies by Jelenc (2007), Ivančič, Špolar and Radovan (2010).

Findings and Conclusions

It is clear that educational institutions have a significant role in determining adequate skills and competencies, but the end users of skills and competencies outcomes are companies. Knowledge-based economies rely on individuals and their skills and competencies, shaping companies' economic performance. Therefore, the role of stimulating skills formation in Slovenia should become a shared responsibility of individuals, educational institutions, and government. More cooperation between educational institutions and businesses is necessary to design adequate educational pathways for effective skills matching in companies. Neglecting the fast changes of labour markets and economies does not allow fragmented and partial investments into the human capital. Motivating each stakeholder to invest in skills and competencies requires confirmed value added for each of them. In times of demographic decline in Slovenia, special emphasis and motivation measures should be targeted towards unemployed and inactive ones.

OECD confirms the prominent role of the government and society in the recent study in adult learning in Slovenia. The study stated that the governments and society benefit most from increasing the basic skills and competencies of its population, while employers benefit from job-specific training leading to productivity gains, and individuals benefit from training that raises their employability or mobility in the labour market. How to share the "funding agreement" should base on i) who benefits from different types of adult learning and skills; ii) who incurs costs due to adult learning;

and iii) who has the capacity to pay for adult learning and skills (OECD, 2018).

Skills forecasting is an essential tool for mirroring the economy's potential in the individual country. As identified by OECD (2017), Slovenia lacks a comprehensive skills assessment and anticipation system. The aforementioned is a precondition for identification of needs and adequate future economic policies. The same analysis also confirmed that the actual tax system does not motivate highly skilled individuals to invest in (new) skills and competencies. The aforementioned challenge of skills forecasting gap and skills and competencies investments should be better recognised, highlighted and discussed in the Economic Social Council meeting.

From the perspective of the social responsibility, the innovation spillover effect is too modest to generate substantial impacts, especially for companies that are not technological leaders. Investments in knowledge-based capital at the company level could generate a much higher return at national level and in the international environment, leading to progress and welfare for all. Global competition requires fast responses to actual market situations. Knowledge-based capital is becoming a prevailing source of competitive advantage for a company, if invested in individuals. Matching the right people with the right skills requires identifying prospective sectors with available skills and competencies. Industrial policy, focused on sustainable economic direction, should be aligned with appropriate skills strategy to reach best possible economic and social performance.

To conclude, the future of work is unpredictable due to global technological, economic and societal changes. The shift towards digitalisation and new skills and competencies is inevitable, leading to requirements for lifelong investments in Slovene human capital. Skills are crucial for individual employability, lifelong social inclusion, and increased productivity. Europe's economic and social success is largely based on the skills of its population (EC, 2016c). A waste of human resources is a mistake that should not happen.

Ageing trends in Slovenia require up-skilling and increases in productivity to mitigate the negative effects of lower participation rates in the labour market and sustain economic growth. Social partners, especially employers and chambers of commerce, should play an important role in identification of required skills and gaps. Smart skills and competency management, focused financing and more coordination are lacking in Slovenia.

It is clear that investments in skills and competencies are needed in the society. Due to the dynamics of labour markets, it is difficult to predict precisely the long-term evolution of required skills and competencies. To improve the labour market matching and supply of skills and competencies, improvements in governance, cooperation and coordination are easier to predict and to implement. There exist many good practices on how to combine the uncertainty of future needs with better national skills management. It might be wise to follow the best performers in skills achievements. Only by matching required skills with the industrial policy and skills forecasting and competency needs can Slovenia generate the twin goals of higher efficiency of human capital and higher productivity in the economy. Relevant skills and competencies could be better used in the working and civil life and should enable social inclusiveness and lifelong well-being.

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Upravljanje s kompetencami ter koordinacija in odgovornost kompetentnosti v Sloveniji

Izvleček

Namen članka je izpostaviti pomen vlaganja v kompetentnost. Ugotavljanje ravni kompetentnosti mora soditi med strateške cilje družbeno odgovorne družbe. Ustrezne kompetence predstavljajo predpogoj delujočega trga dela v času digitalizacije in tehnoloških sprememb, predpogoj za uspešnost gospodarstva ter za produktivne in aktivne posameznike skozi celoten življenjski cikel. Ustrezne veščine in kompetence morajo ustrezati potrebam trga dela in zahtevam gospodarstva. Raziskava se navezuje na praktične pomanjkljivosti neučinkovitega upravljanja kompetenc v Sloveniji in na njene posledice. Uporabljena metodologija združuje preučitev teoretičnih modelov in okvira veščin v izbranih državah z izbranimi politikami.

Ugotovitve potrjujejo, da izobraževalne poti v Sloveniji niso usklajene z zahtevami gospodarstva. Kompetence ne ustrezajo dejanskim prednostnim nalogam industrijske politike. Članek opiše aktualnost politike kompetentnosti v Sloveniji in razkorake v upravljanju v primerjavi z državami EU in OECD. Osredotoča se na predvidene izzive glede veščin in na potrebe po napovedovanju veščin. Članek predlaga rešitve in politike za boljše usklajevanje veščin in za nadaljnja razmišljanja o uspešnejšem usklajevanju in upravljanju med izobraževalnimi politikami ter zahtevami kompetentnosti v gospodarstvu. Omejitev raziskave predstavlja raznolikost politik v državah, kar predstavlja oviro prenosljivosti dobrih praks. Kljub temu se članek dotika izzivov veščin in kompetenc, ki so skupne večini držav in zahtevajo ustrezno ukrepanje.

Ključne besede: kompetence, neusklajenost veščin, razkorak med veščinami, industrijska politika, napovedovanje

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STEM on Demand – Can Current State of Higher Education Infrastructure Meet Expectations?

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Abstract

One of the biggest challenges facing the education system in Bosnia and Herzegovina is bridging the gap between the current state of higher education and the demand for research, innovation and a robust STEM (Science, Technology, Engineering, Mathematics) curriculum. Higher education instiutions (HEIs) face poor R&D infrastructure while companies struggle with limited resources and the lack of internal researchers, all of which affect their capabilities to utilize university knowledge and research that will lead to further collaborations and innovations in STEM. Universities are primarily seen as a source of future employees as well as as a source of knowledge and innovation. This study aims to provide an overview and systematic analysis of the current state of scientific and research infrastructure and human resources in public and private universities located in the Sarajevo Canton region. This is done by using primary data collected through semi-structured interviews and a self-reporting comprehensive questionnaire in order to identify areas where further reforms and investments are needed. An analysis of the secondary data sources, such as current strategic documents and the existing assessments of education, was conducted. Consequently, this study offers several practical implications, including policy recommendations in areas such as higher education, research infrastructure and academic excellence, cooperation with the private sector, and IT infrastructure improvements.

Keywords: STEM, education, infrastructure, development

Introduction

Higher education development and modernization are ranked high on the list of priorities at both national and regional levels in countries across Europe. The decision-making processs in education is almost always tied to economic strategies and planning. The Europe2020 Strategy is a 10-year European Union (EU) road map for growth and jobs that promote smart, sustainable, and inclusive growth, emphasizing in particular the importance of education in the overall process. This stategic document identified several significant initiatives, including: Education and training – ET2020 (Council, 2009); Rethinking education: investing in skills for better socio-economic outcomes (European Commission, 2012); Modernising universities (European Commission, 2006); Internationalisation in European

higher education (EUA, 2013), among others. When it comes to education system reforms, a majority of those focus on

- Increasing the number of university graduates;
- Improving the quality and relevance of teaching and learning;
- Promoting student and teaching staff mobility and cross-border cooperation;
- Strengthening the „knowledge triangle" that links education, research and innovation;
- Creating effective governance and funding mechanisms for higher education (European Union, 2011; EUA, 2013; European Commission, 2013):

In the overall process, it is universities that provide new, contemporary knowledge that is keenly sought after and applicable in national economies, with the ultimate goal of improving national competitiveness, exporting growth, employment and general economic and social progress. However, countries today face challenges such as a lack of collaboration between higher education institutions (HEIs) and industry, university collaboration (especially in terms of new curriculum development), infrastructure investments and improvements, educated academic staff, adequate management, among others. Thus, the question that arises is: is the current education model, with its respective capital (human and other forms), fit for modern STEM (Science, Technology, Engineering and Math) education and demands? Given Bosnia and Herzegovina's (B&H) strategic commitment to European integrations, work needs to be done to create a „knowledge-based economy", i.e. an economy that will be competitive in both regional and global contexts. Continuous modernization of higher education system is becoming an imperative, subject to long and demanding reforms. Recognizing the complexity of higher education systems and the fact that HEIs are often the driving force behind all major social changes, this study aims to answer the following research questions (RQ) in the context of Bosnia and Herzegovina:

RQ1. What is the current state of human resources in Sarajevo HEIs?

RQ2. What are HEIs member's assessments of the quality of available research and scientific infrastructure?

RQ3. What are the main limitations in STEM research and scientific activities identified by the HEIs members?

The research focus in this study is on higher education in the Sarajevo Canton[1], its existing human, financial and infrastructural resources in the context of wider development goals and creation of knowledge-based economy. A comprehensive analysis was conducted to assess the existing state of education system and its research infrastructure in Sarajevo. This analysis included an evaluation of key resources and processes based on both primary and secondary data sources, followed by interpretation and discussion with the final goal of defining policy recommendations and promoting evidence-based decision making in education. Primary data sources include semi-structured interviews and a self-reporting comprehensive questionnaire in order to identify areas where further reforms and investments are needed, while secondary data sources include strategic documents and the existing assessments of education system.

In the Section 2 of this paper, we discuss a conceptual background of the study by presenting a literature review on the importance of building and modernizing capacities and infrastructure in education. We also discuss the contemporary views on STEM and fully utilizing its potential. In Section 3, we provide a brief overview of higher education system in Bosnia and Herzegovina with its legislative and institutional framework and strategic goals. The methodological framework of this study is presented in Section 4. Results and discussion are provided in Section 5, with specific references to human resources, financial, technical and administrative conditions, and research infrastucture. Concluding remarks, research limitations and indications for future research are in Section 6. Practical implications and recommendations are presented in the final section.

Conceptual Background

Literature review on the importance and challenges of STEM education

STEM education has become a very important topic in contemporary discussions and education initiatives and are dominating the global landscape of educational reform (Yanez et al., 2019). It is considered an essential preconditon to a country's innovative capacity-building and competitiveness. Development strategies of countries around the world are focused on building knowledge-based economies; however, most of the countries are most concerned about the possible shortages of STEM knowledge, both on the students' and educators' sides. The demands for STEM are changing and STEM is becoming more globalised (Seymour & Hewitt, 1997; Prados, 1998; Butz et al., 2006). STEM courses have become very prestigious, attracting the best students with the promise of prestigious careers and high salaries. Public returns on investment into STEM education are focused around the significant contribution of STEM education to

[1] Sarajevo Canton is one of 10 cantons of the Federation of Bosnia and Herzegovina in Bosnia and Herzegovina.

different health research aspects, smart energy solutions etc., that eventually contribute to both an individual's and society's welfare. However, there is a concern that even though access to STEM has increased, the success and retention of these students has not signficantly increased (Sithole et al., 2017). Carlisle & Weaver (2018) address the need for more STEM graduates and for changing the nature of STEM education, focusing on the changes in teaching, promotion, scholarships, etc. Even though STEM is dominating in the global education reform debates, it is implemented into traditional pedagogies, systems and practices (Yanez et al., 2019) and fails to translate innovations in policy into innovations in pedagogy and thus neglecting the impact of science and technology in physical and social worlds of today (Murphy et al., 2017; Zeidler, 2016).

Literature review on HEIs- industry collaboration and its constraints

STEM education today is a vehicle for innovation and technical solutions to global problems (Weinstein et al., 2016). During their higher education, students from STEM fields are exposed to the scientific and technical knowledge generated by academic research (Colombo & Piva, 2020) and STEM graduates become entreprenuers themselves, sometimes immediately after graduation (Colombo et al., 2010). Findings on the population of graduates (2005-2009) from Milan (Italy) reveal that graduates are more likely to become entrepreneurs immediately after graduation if their university curricula are more specialized in a limited number of scientific and technical fields (Colombo & Piva, 2020). Collaboration between universities, research institutions, and businesses will increase innovativness in the business sector and thus improve the competitiveness of national economies (Lööf & Broström, 2008; Belderbos et al., 2004; Lööf & Heshmati, 2002; Buganza & Verganti, 2009). However, knowledge transfer can only be improved if an adequate infrastructure, in forms of networks and connections, is established. In order to fully utilize the possibilites and multiple benefits of STEM education, it is necessary to understand the nature of relationships among key stakeholders and to build STEM networks (Carlisle & Weaver, 2018). STEM networks of different institutions and centers are one of the ways of improving knowledge transfers, which is a precondition for radical innovation (Mohnen & Hoareau, 2003). These networks can take different forms, such as R&D alliances (Hagedoorn et al., 2000); innovation-centred collaboration along the supply chain (Harabi, 1998); or informal social relationships among members of different organizations (Gulati, 1998; Oliver & Liebeskind, 1998). Innovation can only happen at high levels of collaboration and networks, thus leading to open innovations. In this environment, higher education is an important partner to businesses and other stakeholders (Laine et al., 2015). Higher education institutions are an important source of innovation since these institutions educate future generations of workers, create new and improve existing knowledge, and in the end have significant economic and social benefits for societies in general (Cohen et al., 2002; Mansfield, 1991; Pavitt 1991; Salter & Martin, 2001). The main constraints to digital innovation at HEIs are limited infrastructure and resources, a lack of funding opportunities, insufficient technological resources, a conservative academic culture, and a lack of technical support (Vicente el al., 2020). Thus, it is of imense importance to minimize the contraints and allow STEM to reach its full potential by contributing to the overall economic goals.

Higher Education in Bosnia and Herzegovina

Higher education in B&H is regulated by the Framework Law on Higher Education in Bosnia and Herzegovina (Official Gazette of B&H, 59/07, 59/09), while the Law on Higher Education of the Sarajevo Canton (Official Gazette of the Sarajevo Canton, 33/17) is coordinated with the Framework Law. On the basis of the Framework Law on Higher Education, the Law on Higher Education in the Republika Srpska, ten cantons in the Federation of B&H (FB&H) and the Brcko District of B&H are also coordinated, and have completely transferred B&H education to the Bologna process. In addition to the Bologna reforms, the education system in B&H is in the process of transition, undergoing a demanding process of adapting education to market trends. Although B&H signed the Bologna Declaration in 2003, progress in this area was only visible after the adoption of the Framework Law on Higher Education in 2007. This law established two new state institutions, the Agency for the Development of Higher Education and Quality Assurance and the Center for Information and Recognition of Documents in the Field of Higher Education. Accreditation of higher education institutions is performed by the Agency for the Development of Higher Education and Quality Assurance, which has so far accredited 30 public and private institutions in B&H (HEA)[2]. In order to further integrate into the European Higher Education Area to ensure the quality of higher education and to internationally recognize diplomas of foreign higher education institutions, further capacity building of existing institutions is needed. This would ultimately accelerate the transition between education and the labor market. With regard to B&H strategic commitment to European integrations, it is necessary to keep in mind the current trends in the development of education in EU countries. The higher ed-

[2] Agency for Development of Higher Education and Quality Assurance of Bosnia and Herzegovina

ucation system of B&H needs to be in line with European trends because, given the importance of higher education, only cooperation and coordination of higher education, technology, innovation and the private sector can improve national competitiveness in the regional and European context. The field of education is significant for B&H from the perspective of the negotiation process for a full EU membership. Namely, from the experience of the Republic of Croatia, we can see that the negotiations within the chapter of Education and Culture are a framework for the internationalization of education of the candidate country.

Higher education in B&H, as in most countries in the region, has been the subject of long and demanding reforms. In a significant number of cases, reform processes in the last two decades were supported by a large number of international organizations and institutions. Current priorities of higher education in B&H are: good governance and management; resources; the relationship between the labor market and higher education; qualification standards; student experience; internationalization and statistics (EU/CoE, 2015). In terms of entity level, the Federal Ministry of Education and Science defined its goals for the period 2012-2022 in FMON (2012), while government of Republika Srpska also defined its strategic goals for higher education for the period 2016-2021 (Vlada RS, 2016). Highly decentralized education decision-making in B&H should enable institutions to be more flexible and specific in defining policies and instruments. However this is not the case.

Methodological Framework

Higher education institutions are key actors in the education process in the Sarajevo Canton, where one public (University of Sarajevo) and three private universities (University of Sarajevo, School of Science and Technology; International University of Sarajevo; and International Burch University) are located. All of these institutions are accredited by the Agency for Development of Higher Education and Quality Assurance. Taking into account that almost half of the graduates (46.5%) in B&H graduated from the universities in the Sarajevo Canton and that the oldest and largest university in B&H (University of Sarajevo)[3] is located in the Sarajevo Canton, the role of this region in the overall education is highly significant for the entire country.

This study employs both primary and secondary data sources in the process of answering the main research question. Primary data sources include the conducted semi-structured expert interviews and self-reporting comprehensive questionnaire. Interviews were held with representatives of key higher education institutions in Sarajevo Canton between September and December of 2019. A self-reporting comprehensive questionnaire was distributed during the intervews with the main aim of assessing the current state of research infrastructure including research centers and laboratories. The following universities participated in the study: University of Sarajevo (UNSA); International University of Sarajevo (IUS) and Burch International University (Burch). A descriptive study approach has been implemented. The secondary data sources include publicly available data from the universities‘ websites, scientific research institutions and other data sources such as offical statistics from different administrative levels and education institutions. This analysis includes an overview of the existing infrastructure, adequate administrative support, financial and technical conditions, and an analysis of academic and research staff at higher education institutions in the Sarajevo Canton.

[3] Around 91.6% of the total students in the Sarajevo Canton are enrolled at the University of Sarajevo (BHAS).

Results and Discussion

The results are presented in two different areas, i.e., human resources and infrastructure according to research questions.

Human resources – current state and future development

The data collected show that the total number of academic staff participating in the teaching and research processes at higher education institutions in the Sarajevo Canton is 2690. Academic staff (those directly involved in the teaching and research process) total 1476 and are employed full-time. Around 88.5% of them are employed by UNSA, and the other 11.5% by other private universities (Table 1).

Table 1. Structure of academic staff by title and type of employment at higher education institutions in Sarajevo Canton

Academic title	Full time employed	Shared employment	Visiting academic staff
Professors	232	162	124
Associate professors	324	141	148
Assistant professor	434	152	174
Senior teaching assistants	304	99	87
Assistants	158	84	41
Lectors	24	2	0

Source: author's calculations (questionnaire and IBU;IUS; SSST).

In percentages, this means that 55% of academic staff are employed full-time, 24% are academic staff with shared employment (usually 20% or maximum 50%), while visiting academic staff from other universities in B&H or abroad make 21% of the total academic staff. An analysis of the progression of academic staff was conducted, in the context of the advancement of the existing academic staff and the average number of new employees at universities, and it is presented in Table 2.

As can be seen from Table 2, there is a noticeable imbalance between full professors, associate professors, and assistant professors on the one hand and senior teaching assistants and assistants on the other hand. Therefore, one of the strategic planning measures should be aimed at improving this relationship and preventing academic aging at the higher education institutions in Sarajevo Canton. Regarding the quality of teaching and research activities of academic staff, the majority of interviewees pointed out the need to improve the following areas: (1) financial conditions, (2) technical conditions and (3) administrative support. It is necessary to establish transparent and publicly available funding principles for universities in the Sarajevo Canton area, including public and private universities; that is, to ensure uniform criteria for allocation of funds from the Sarajevo Canton budget, as well as the criteria and procedures for determining the amount of tuition and/or the cost of studies at both public and private universities. In order to improve the quality of teaching, as well as scientific and research activities, it is necessary to provide adequate funds in the form of a fund to support these activities, and to establish an adequate system of rewarding academic excellence. The implementation of a high-level teaching process and high-quality scientific and research projects (scientific and commercial research) requires technical conditions, which include, among other things, proper equipment such as classrooms, laboratories and research centers. Therefore, it is necessary to provide adequate material, and technical and infrastructural prerequisites for a high-standard performance.

Higher education infrastructure

The state of higher education infrastructure in the Sarajevo Canton is analyzed based on both primary and secondary data sources. The research shows that all universities in the Sarajevo Canton have their own library holdings; however, there is a trend of decreasing investment in enriching them. One of the measures that would significantly improve the scientific and research work in higher education institutions would be the provision of relevant literature at the universities and university libraries, as well as electronic access to databases of scientific and professional publications. A classification of laboratories and research centers by purpose in higher education institutions in the Sarajevo Canton has been carried out. The classification of laboratories and their numbers is shown in Table 3 below.

Table 2. Number of newly employed and promoted academic staff at higher education institutions in Sarajevo Canton

	Promotion at home university		Newly employed at University	
	UNSA*	Private universities in Sarajevo Canton**	UNSA*	Private universities in Sarajevo Canton**
Professors	33.7	6.3	0.0	1.8
Associate professors	71.0	9.3	0.0	2.7
Assistant professor	100.0	26.8	0.0	10.5
Senior teaching assistants	46.3	33.5	0.0	7.7
Assistants	35.0	10.0	0.0	1.2

* Analysis conducted on the sample from the previous three academic years and the number of employees at the expense of Canton Sarajevo.

** Analysis conducted on a sample of the previous six academic years and the number of employees at the private university.

Table 3. Classification of laboratories by purpose

Purpose	Total number at UNSA	Total number at private universities in Sarajevo Canton
Laboratories for teaching	170	5
Laboratories for scientific and research activities	70	8
Laboratories for commercial research	19	0
Research centers (institutes) within universities	6	1
Research centers (institutes) within faculties	35	0

Source: authors‘ calculations (questionnaire and IBU;IUS; SSST)

A majority of the existing teaching and research laboratories are available at the University of Sarajevo. UNSA has over 95.5% of the total available laboratory resources and research centers (institutes) in the Sarajevo Canton. The analysis found that in addition to the existing capacities, there is a need to establish new laboratories that would be used in teaching and research. Over 10% of teaching and research laboratories are no longer usable for their primary purpose. It is encouraging to see that there more than 21% of teaching laboratories meet all the prerequisites. This percentage is slightly higher for laboratories exclusively dedicated to scientific research (34%). However, more than 50% of the existing laboratory resources at UNSA need to be modernized. Also, a number of laboratories primarily intended for scientific research do not have adequate human resources. There are 19 commercial research laboratories operating or under development at UNSA, two of which are in the process of being established and another two in the process of being closed. Taking into account the existing human resources, it is evident that there are preconditions for better functioning of the existing ones, as well as the establishment of new commercial laboratories, which would contribute to the achievement of one of the strategic goals of higher education development, which is cooperation with the real sector.

Concluding Remarks

Globalization, and especially the Europeanisation of higher education, is a key trend in European countries, but at the same time presents a challenge for higher education in Bosnia and Herzegovina. Globalization of higher education implies observation of universities outside the national context, while Europeanization of higher education refers primarily to the case of internationalization of higher education, but inside a European context (limited internationalization to European countries). The importance of education, especially higher education, for the long-term economic and social development of Bosnia and Herzegovina is immeasurable.

Education reform in Bosnia and Herzegovina has been on the agenda for a considerable length of time, but constraints still persist. A highly decentralized legislative framework and decision-making system as well as a lack of collaboration in planning and implementation processes are limiting progres in this area. This research conducted in the Sarajevo Canton among one public and three private universities has shown an imbalance among academic staff in terms of academic aging at HEIs in the Sarajevo Canton. In terms of available infrastructure for STEM research activities, the interviewees have reported that more than 50% of the existing laboratories at UNSA needs modernization. Qualitative methods, in terms of semi-structured interviews and limiting the scope of the research to one region, are the main limitations of this study. Future research in STEM higher education in Bosnia and Herzegovina should be focus on issues such as: the quality of STEM education, differences between STEM education provided by public and private universities, and the gender gap in STEM, among others.

Recommendations

In order to improve scientific production in the Sarajevo Canton, it is necessary to:

- Increase investments through the Fund for Support of Scientific Research and Innovation and stimulate further investments;
- Enrich access to databases of scientific journals and publications and expand the library stock of higher education institutions, which will lead to increased academic and scientific excellence;
- Increase financial and other forms of support for the professional development of teaching and research staff;
- Establish mechanisms that would further regulate the maximum workload of teachers and associates in higher education in the Sarajevo Canton, with the aim of reducing the teaching load and increasing participation in scientific and research projects.

The analysis also identified that there is a need for renovation of the existing and the establishment of new laboratories for use in the teaching process, as well as for scientific and research work. It is necessary to provide adequate investment in the modernization of equipment, laboratories, and other infrastructural capacities of higher education institutions in the Sarajevo Canton (libraries, adequately equipped classrooms, student accommodation facilities, campus, etc.). The following is necessary:

Upgrade and expand the existing higher education information and communication structure in the Sarajevo Canton;

Upgrade and integrate the existing higher education information systems and link them to systems in the field of science and lifelong learning (registry of researchers) in such a way that they provide access to comprehensive and high quality information for higher education decision-making, research, and evidence-based policy).

Stimulate cooperation and networking of higher education institutions and their organizational units in the Sarajevo Canton in order to use the existing human and other resources more efficiently.

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NA-MA na zahtevo – je trenutna visokošolska infrastruktura zmožna izpolniti pričakovanja?

Izvleček

Eden največjih izzivov, s katerimi se sooča izobraževalni sistem v Bosni in Hercegovini, je premostitev vrzeli med trenutnim stanjem visokega šolstva in povpraševanjem po raziskavah, inovacijah in učnem načrtu za NA-MA (naravoslovje, tehnika, inženiring, matematika). Visokošolske ustanove se soočajo s slabo infrastrukturo raziskav in razvoja, medtem ko se podjetja spopadajo z omejenimi sredstvi in pomanjkanjem internih raziskovalcev, kar vpliva na njihove zmožnosti izkoriščanja univerzitetnega znanja in raziskav, ki bi lahko privedlo do nadaljnjega sodelovanja in inovacij znotraj NA-MA. Univerze veljajo predvsem za vire bodočih zaposlenih in tudi za vire znanja in inovacij. Cilj študije je podati pregled in sistematično analizo trenutnega stanja znanstvene in raziskovalne infrastrukture ter kadrov v javnih in zasebnih univerzah na območju kantona Sarajevo. To je bilo izvedeno z uporabo primarnih podatkov, zbranih s pomočjo polstrukturiranih intervjujev in obsežnega samoocenjevalnega vprašalnika, s katerimi smo identificirali področja, kjer so potrebne nadaljnje reforme in investicije. Izvedena je bila tudi analiza sekundarnih virov podatkov, kot so veljavni strateški dokumenti in obstoječa vrednotenja izobraževanja. Posledično ima ta študija številne praktične vidike, vključno s priporočili glede politike na področjih, kot so visoko šolstvo, raziskovalna infrastruktura in akademska odličnost, sodelovanje z zasebnim sektorjem in izboljšave informacijske infrastrukture.

Ključne besede: NA-MA, izobraževanje, infrastruktura, razvoj

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Entrepreneurship vs. Freelancing: What's the Difference?

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Abstract

The development of Internet technology (IT) at the end of the 20th century and its integration into the business sector has led to the emergence of digital labour platforms that provoke a reorganization of work arrangements by matching the demand and supply of goods and services, known as the "gig economy". The "gig economy" stands for economic activities or work arrangements related to the performance of very short-term tasks facilitated by digital platforms and can include freelance work, temporary work, work on-demand and contract work. Our paper focuses on the new, growing workforce of freelancers. Freelancers belong to the self-employed category of entrepreneurial activity who do not employ workers, who pay their own taxes, work on projects, work for several clients, and work remotely, usually from home. According to various sources and findings, they are also referred to as entrepreneurs, solopreneurs, digital micro-entrepreneurs, hybrids of employees and entrepreneurs, enablers of entrepreneurship, potential entrepreneurs, etc. The purpose of this paper is to examine the relationship between freelancers and entrepreneurs. The paper will use a literature-review approach to highlight the similarities and main differences between freelancers and entrepreneurs and to find an answer to the question whether freelancers can be considered entrepreneurs or not. In addition, the paper provides insights into freelance work and highlights the benefits and challenges that freelancers face in the labour market.

Keywords: digital labour platforms, entrepreneurship, freelance work, gig economy

Introduction

Thanks to the Internet, people are able to compete for jobs and offer their knowledge and skills worldwide. In addition, business processes are becoming increasingly fragmented, so that work can be broken down into smaller components, so-called short-term projects (Friedman 2014; Stone & Deadrick 2015). The market

system, which stands for the involvement of organizations and workers in short-term work arrangements, is called the gig economy. These types of work arrangements are often referred to as alternative or non-standard work arrangements carried out by gig workers or so-called independent contractors (Friedman, 2014), more commonly known as freelancers (Gig Economy Data Hub, 2019).

According to American, British and European findings, the gig economy is a new and as yet unknown phenomenon, which is reflected in the growing number of online labour platforms (Green, 2018) for job placement worldwide. As far as the US is concerned, 36% of the workforce is part of the gig economy, and forecasts show that if the gig economy continues to grow at its current pace, more than 50% of the US workforce will be participating in it by 2027 (Milenković, 2019). In terms of global gig economy statistics, 20-30% of the US and EU-15 labour force is involved in the gig economy (McKinsey, 2016). The UK gig economy also appears to be following in the footsteps of the US in terms of growth (Partington, 2019).

In addition, it is important to point out that some authors claim that the gig economy considers not only work controlled and delivered remotely and over digital platforms, but also work delivered locally. Such local gig work typically includes food delivery, curation, transportation, services, and manual work. Remote gig work, on the other hand, consists of the remote delivery of a variety of digital services ranging from data entry to software programming via online labour platforms (Huws et al., 2016). Payoneer's Freelance Income Report shows, however, that more than 70% of all freelancers find projects via gig websites. Some of the largest websites offering gig work are Upwork (with over 15 million users), Fiverr, and Freelancer (Milenković, 2019). This also supports an index that measures the use of online labour platforms (i.e. OLI) and shows that their use is increasing at an annual rate of 26% (Kässi & Lehdonvirta, 2016).

The aim of this paper is therefore to study the entrepreneurial form of self-employment - the freelancers. In the first part of the paper we will give insights into freelance activity and highlight its advantages and challenges. In the second part, we will use the existing literature to examine the similarities and differences between freelancers and entrepreneurs, regardless of whether freelancers are also considered entrepreneurs or not. We will try to answer the following questions:

Can freelancers be identified as entrepreneurs? What are the differences between freelancers and entrepreneurs?

The second part is followed by conclusions.

Theoretical Background

As already mentioned in the Introduction, freelance activity as a non-standard and flexible work arrangement is part of the gig economy. Shevchuk and Strebkov (2012) characterize freelance workers who work remotely as *individuals with a higher entrepreneurial spirit and human capital, who provide creative and knowledge-intensive services* and *take advantage of the global Internet era while maintaining their work.*

In the early literature on freelance careers, freelancers were initially described as *borderless workers*. The term was created in the mid-1970s through the initiative of career studies led by scientists in the Massachusetts Institute of Technology. The origin of this name lies in the fact that freelancers know no boundaries when it comes to fulfilling their tasks. Such an approach implies a shift from individuals relying primarily on career development organizations to individuals taking responsibility for their own career management and employability (Hall 2004; Rousseau 1989; Sullivan & Baruch, 2009). Due to the growth of technological development and globalization, traditional linear career development can no longer be used to adequately explain the reality of modern careers and thus the needs of the labor market. Individual knowledge, skills, expertise and adaptability are becoming more important than organizational commitment (Sullivan & Baruch, 2009). Accordingly, traditional working hours have been replaced by more flexible work arrangements and autonomy. *Boundarylessness* does not necessarily mean the complete absence of boundaries between different areas of life, but it illustrates weak to virtually non-existent area boundaries (Ezzedeen & Zikic, 2017). According to Donovan et al. (2019) and Utz (2016), in the business model, companies (clients) are looking for freelancers (providers) of services for a specific task through online labour platforms or other applications (intermediaries). Freelancers enter into formal agreements with companies to provide services upon request and receive financial compensation for the work performed.

Since it applies to the category of self-employed with zero employees (Sapsed et al., 2015), many self-employed people in modern economies contribute significantly to economic prosperity by enabling client firms to operate more flexibly and cost-effectively, and by introducing innovations in their client firms (Burke & Cowling 2015). On this basis, therefore, we will examine the advantages and challenges of freelance activity in the following section.

Advantages and Challenges of the Freelance Activity

Since the business environment is very dynamic and market demand is changing rapidly, freelancers represent the

external resources for new solutions. In order for companies to respond quickly to market changes, they rely on hiring freelancers who can do a job that no one else in the company can do. Moreover, freelancers are usually specialists in their respective fields and are occasionally suitable for niche tasks (Brinkely, 2016).

The most common reason for hiring a freelancer is cost efficiency. Freelancers work remotely, usually from home, and companies are not obliged to provide them with space and equipment for their work. Additionally, freelancers are usually paid by the hour for their work, and the company that employs them does not pay health insurance, pension benefits or other contributions (O'Donnell, 2020). This is followed by risk mitigation, as the cooperation can be terminated relatively easily if the freelancers do not perform according to the expectations of the companies.

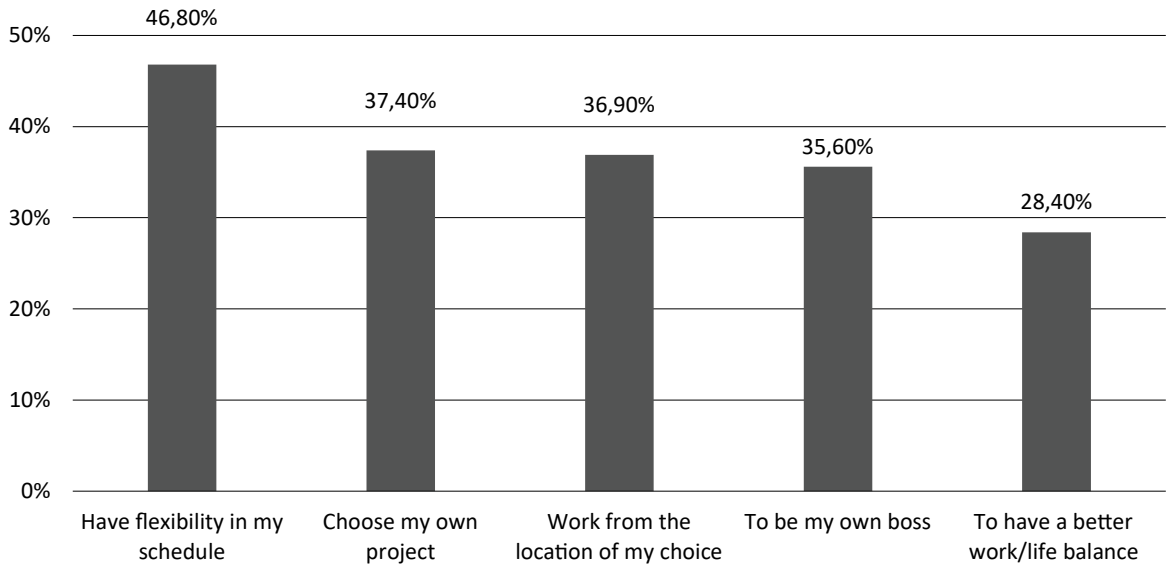
Freelancers generally require a low level of supervision, mentoring and guidance through work. This saves time for many companies as they can concentrate on other tasks. In order to provide added value, the freelancer must be willing to take the initiative and do the best possible work (Kirk, 2020). Many freelancers claim that freelance work is hard work, although it allows freelancers to work from the comfort of their own homes. Success in freelance work requires great communication skills, lots of learning, determination, perseverance and self-discipline (Dam, 2019). Freelancers must market themselves because they are the only ones responsible for finding their next client (Artisan, 2017). In this way they are able to deliver work of high quality. Hiring a freelancer also gives the company a global reach in talent selection for the work to be done. Finding talent through online labour platforms has never been easier.

Furthermore, many authors find that people are motivated by push and pull factors to become a freelancer. The former represents unemployment and underemployment (Bertram, 2016, p. 24; Block & Hennessy, 2017; Coyle, 2017; Tran & Sokas, 2017), while the latter represents extra income and flexibility as well as interaction with clients and interest in entrepreneurship (Anderson, 2016; Carboni, 2016; Webster, 2016). Furthermore, Sapsed et al. (2015), divide freelancers' motivation into three factors: aspirations, pay, and necessity. Aspirations are the realization of one's own ideas and the flexibility of work, pay is, of course, earning money, and necessity is the reasons for engaging in freelance work, such as dismissal and the inability to find a steadier job. According to Van den Born and Van Witteloostuijn studies in 2012, the main motive for workers to participate in the gig economy is flexibility, followed by autonomy and money. Also, according to the results of the First European Freelance Study (2019) 76.6% of participants were involved in the freelance work by choice. The main reason is flexibility, followed by the other reasons shown in Figure 1.

The main obstacles identified by respondents were finding customers (57%) and monthly or weekly income fluctuations (46%) (Malt & EFIP, 2019).

With regard to the other challenges, competition is high. In order to be successful, the freelancer must constantly work on his skills, knowledge, communication abilities and

Figure 1. First European Freelance Study – reasons to become a freelancer



Source: Malt and the European Forum of Independent Professionals (EFIP), 2019.

the portfolio they offer. Working as a freelancer therefore requires a high degree of self-study (Eden, 1973; Akhmetshin et al., 2018). As the result, their income depends only on the capabilities of the freelancer himself. As freelancers fall into the category of the self-employed, they do not receive benefits such as pensions, sick leave, paid leave, or health insurance (Akhmetshin et al., 2018).

Consequently, 63% of respondents still believe that they should be better recognized and supported by policymakers to maximize their potential (Malt & EIPF, 2019). There is still a lack of institutional recognition, although existing European and other international research suggests that it is one of the fastest-growing forms of contemporary employment arrangements. There are still no agreements on the definition and classification of gig workers. Mould et al. (2013), find that the lack of information and empirical data on freelancers explains the lack of government support. A global official register for such a new workforce does not exist, and for this reason the classification of freelancers varies from country to country or does not exist at all. Freelancers are often identified as entrepreneurs rather than being perceived as the unique economic entity, which will be discussed in the next section.

Disscusion on Entrepreneurship vs. Freelancing

As mentioned in the previous section, there are still different classifications of gig workers. Many authors have examined the differences between a freelancer and an entrepreneur and have developed different approaches.

Although freelancers are often referred to as entrepreneurs, solopreneurs (Fitz, 2019), digital micro-entrepreneurs (Malaga, 2016), etc. some authors clearly distinguish between freelancers and entrepreneurs. Other authors offer a more balanced view of a freelancer compared to an entrepreneur. They find that freelancers can be seen as a *hybrid of employees and entrepreneurs*. They find that freelancers are similar to employees in that they are typically hired by large companies to use their professional knowledge for a certain period of time, as opposed to entrepreneurs who sell tangible products to customers. However, they also argue that freelancers are entrepreneurs because they work at *their own risk*, work for themselves without organizational support, and use their capabilities to create value (Van den Born & Van Witteloostuijn, 2013). This is why they are so often considered to be entrepreneurs themselves when they take risks.

On the other hand, the authors, who make a clear distinction between freelancers and entrepreneurs, claim that freelancers are unique economic entities that promote and enable entrepreneurship. With regard to the category of employment, they state that freelancers belong to the category of self-employed with zero employees, who use their potential to apply for temporary jobs or projects. In addition, they pay their own income taxes, have full control over where they work (usually remotely), do not receive benefits from companies, usually work with several clients and projects at the same time, and set their own rates, whether they charge by the hour or by project (Darlington, 2014). In contrast, they state that an entrepreneur is someone who owns a small business, aims to run and develop a business, has employees, i.e. hires people, and buys resources (products) from others to sell them profitably (Nation 1099, 2020). This means, for example, if a furniture designer sells his skills to a furniture company, the designer is clearly a freelancer as long as he designs the furniture himself. Only when the designer stops outsourcing construction activities and hires people to make the furniture is the designer no longer a freelancer and becomes an employer (Van den Born, 2009; Kazi et. al 2014).

In terms of the promoters of entrepreneurship, Burke (2012), in his report *The role of freelancers in the 21st century British economy* summarises four effects that occur when companies turn to freelancers: capability, productivity, reduced risk and competitiveness. These effects are explained in more detail in Table 1 below.

Table 1. Hiring freelancers - economic added value

CAPABILITY	Access to a wide variety of talent/Reduced finance constraints
PRODUCTIVITY	Specialisation of labour/Reduced worker downtime/Ability to transform an organisation
REDUCED RISK	Lower sunk costs/Variable cost model
COMPETITVENSS	Lower barriers to entry/Reduced minimum efficient scale

Source: Burke, 2012.

Burke (2012), points out that companies can improve their own efficiency and thus their performance through these effects. The availability of freelancers lowers entry barriers and thus increases competition and economic efficiency. In this way, freelancers can play a significant role in the development of a start-up or a company, and a team could consist of a mixture of employees and freelancers. Other authors also point out that freelancers are the focus of attention, with the aim of enriching our understanding of the contextualization of entrepreneurship (Ucbasaran et al., 2001). Consequently, they are also perceived as enablers of entrepreneurship. They enable entrepreneurs to give up impure risks and thus generate more entrepreneurial activity

(encouraging innovation). One of the characteristics of successful entrepreneurs is their ability to avoid risk by spreading the risk across a portfolio of projects and ventures (Burke et al., 2010). Freelancers create more opportunities for entrepreneurs and companies to adopt these strategies. Instead of having to tie themselves to long-term contracts to secure workers from a new company, companies can employ freelancers on short-term contracts. The risk is transferred from the entrepreneurial venture to the freelancer, since freelancers are usually paid for the output of their work and not for the input, so they take on general business risk. They also free companies from the constraints of their internal resource base and enable them to take advantage of exceptional talent that would otherwise not be economically viable with employment contracts (Burke, 2012).

In most cases, freelance work serves as the basis for entrepreneurship, and entrepreneurship drives economic innovation and job creation (Kazi et al., 2014). Moreover, the Global Entrepreneurship Monitor, best known international research on entrepreneurship states that gig workers are also an interesting pool of potential entrepreneurs (GEM, 2019).

Burke and Van Steel (2011) provide the approach that defines freelancers as unique economic entities. Table 2 below shows the labour force in a 2x2 matrix based on the double distinction of whether a person is employed or self-employed and whether he or she is a manager or worker. The table shows that while freelancers are self-employed, their unique function is not that of a business owner. They are primarily workers on their own account.

Table 2. Labour Force Functional Categories

	Manager	Worker
Employed	Executive	Employee
Self-employed	Entrepreneur	**Freelancer**

Source: Burke and Van Steel, 2011.

Taking into account freelancers as a unique economic entity, Van den Born and Van Witteloostuijn (2013) have developed a model of freelance career success, which provides a basis and insight for further research directions. Their model is developed on the basis of an intelligent career framework (Parker, Khapova & Arthur, 2009), and a protean career model (Hall, 1970; Hall, 2004). The protean career model represents a career orientation in which the main success criteria are subjective. The intelligent career model was developed for intelligent firms, and it is suitable for the career of freelancers, because they sell their knowledge and skills. Due to the fact that a freelancer is self-employed, the self-employed drivers are seen as the result of entrepreneurial performance and entrepreneurial success. According to the literature on entrepreneurship, a considerable amount of research has been devoted to identifying personal traits and other characteristics associated with entrepreneurial performance and success. The results show that personality traits, motivation, human capital, and social capital characteristics are generally associated with above-average performance and what it takes to be successful in the entrepreneurial profession (Sorensen & Chang, 2006). These constructs should therefore be considered for a future research model. This approach overlaps with the intelligent career model, in which personal traits reflect knowing why variable, human capital reflects knowing how variable and social capital reflects knowing whom variable. The model combines the individual characteristics of the entrepreneur. The intelligent career model considers the intrinsic factors of the entrepreneur but ignores the effect of the external environment in which an individual freelancer works. We believe that these factors must also be identified and included in the analysis.

Conclusion

Given the assumptions of the paper, our aim was to provide insights into the growing number of new workers: freelancers. Freelancers are part of the gig economy, which has come to the fore in recent years due to the growing number of online labour platforms offering remote work worldwide through non-standard work agreements.

Freelancers are an external source of knowledge and skills for companies and therefore offer many advantages. Freelancers are self-employed with zero employees. Their unique function is not that of business owners. They work primarily for their own account. Since they are self-employed and to a certain extent responsible for finding their own work, they take risks and participate in risky projects, and for this reason are often identified with entrepreneurs. In the entrepreneurship literature, however, they are recognized as promoters and enablers of entrepreneurship. Hiring freelancers can improve the performance and productivity of companies, reduce risk and increase their competitiveness, and influence innovation and efficiency.

One disadvantage in their profession is that they are still not sufficiently recognized and protected by society and government to receive support for developing their potential. Consequently, as limitations of the paper, there is not much literature and empirical research that would reveal statistical differences between entrepreneurs and freelancers, e.g. in personality traits or even in entrepreneurial orientation or risk-taking, as is usually practiced between entrepreneurs and managers. But for some further research such an aspect of research can be considered. For future research directions,

statistical analysis could be carried out on the sample of labour force categories with regard to some research aspects (characteristics) in order to determine the clear distinctions between them. Developing a framework for the freelance career success model based on the career and entrepreneurship literature would provide a better insight into the specifics and challenges by evaluating the empirical results for specific factors. Some evidence suggests that the work characteristics of freelancers are related to entrepreneurial skills. By identifying and analysing certain constructs that would be used as preconditions, it is also possible to develop the entrepreneurial predictors that influence the motivation of freelancers for a future entrepreneurial career. Accordingly, future research should consider a study with a larger sample of freelancers to imply a model of career success and a sample of entrepreneurs to assess the differences between them. To assess whether the freelancers are potential entrepreneurs, long-term research is also considered.

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Podjetništvo in freelancing: Kakšna je razlika?

Izvleček

Razvoj internetne tehnologije ob koncu 20. stoletja in njeno vključevanje v poslovni sektor sta privedla do pojava digitalnih delovnih platform, ki povzročajo reorganizacijo delovnih dogovorov z usklajevanjem povpraševanja in ponudbe blaga in storitev, znane kot »gig ekonomija«. »Gig ekonomija« zajema gospodarske dejavnosti ali ureditve dela, povezane z izvajanjem zelo kratkoročnih nalog, ki jih olajšujejo digitalne platforme. Te oblike vključujejo freelance delo, začasno delo, delo na zahtevo in pogodbeno delo. Naš prispevek se osredotoča na novo, rastočo delovno silo – freelancerje. Freelancerji pripadajo samozaposleni kategoriji podjetniške dejavnosti, ki ne zaposluje delavcev, plačuje lastne davke, delajo pa na projektih za več strank in na daljavo, običajno od doma. Glede na različne vire in ugotovitve jih lahko opredelimo tudi kot podjetnike, samostojne podjetnike, digitalne mikropodjetnike, hibridne podjetnike/zaposlene, kakor tudi kot morebitne potencialne podjetnike ipd. Namen prispevka je preučiti odnos oz. razmejitev med freelancerji in podjetniki. Cilj prispevka je na podlagi pristopa pregleda obstoječe literature preučiti in poudariti ključne podobnosti in glavne razlike med freelancerji in podjetniki ter tako najti odgovor na ključno raziskovalno vprašanje, ali se lahko freelancerji štejejo med podjetnike ali ne? Poleg tega prispevek ponuja vpogled v samostojno delo ter poudarja prednosti in glavne izzive, s katerimi se freelancerji srečujejo na trgu dela.

Ključne besede: digitalne delovne platforme, podjetništvo, freelancersko delo, gig ekonomija

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