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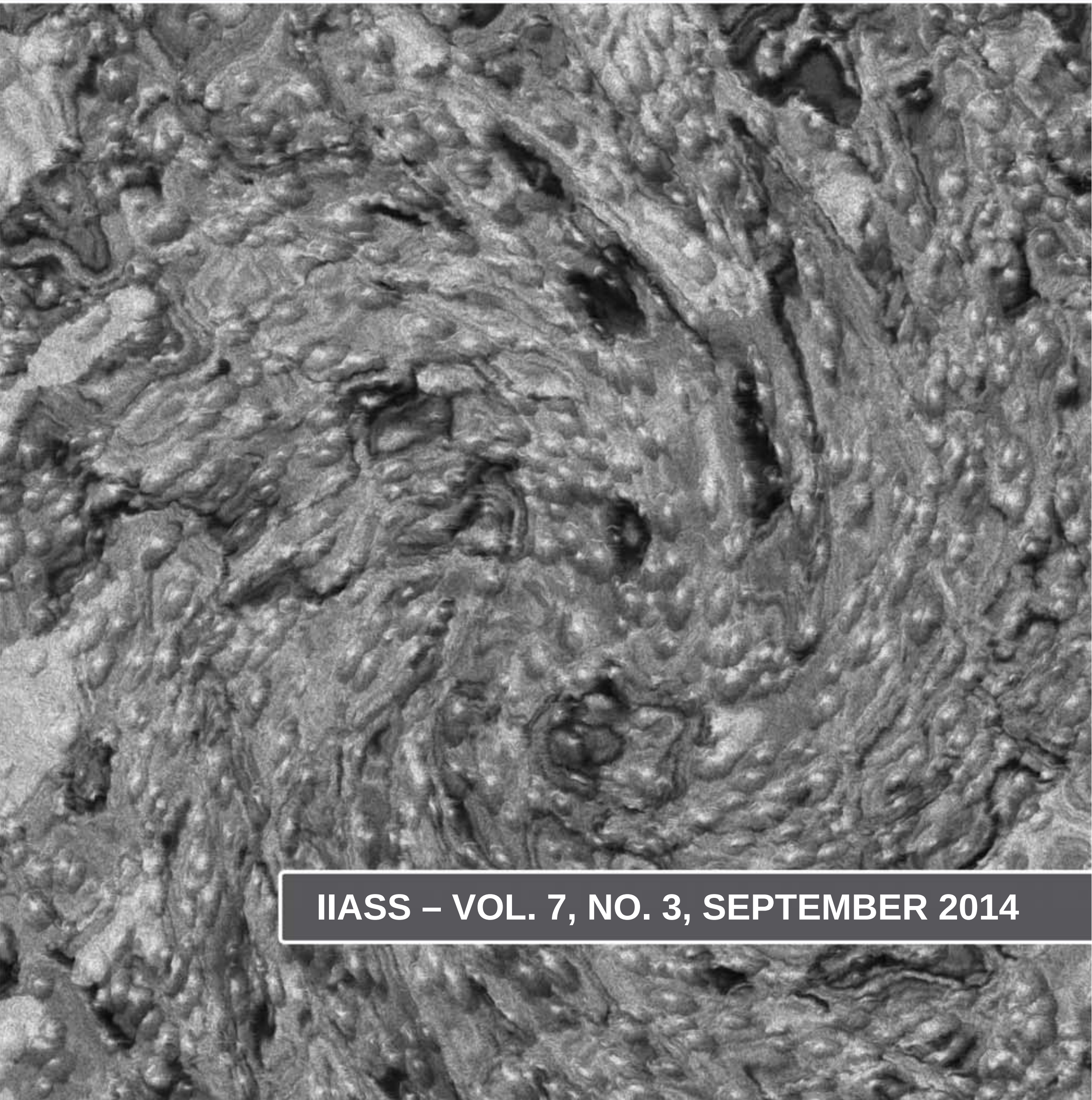

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MODELING THE QUALITY OF LIFE - ECONOMIC GROWTH FUELLED BY TECHNOLOGY RESEARCH, INNOVATION AND KNOWLEDGE

Katja Rasic,[1] Matjaz Mulej,[2] and Vesna Cancer[3]

Abstract

The paper attempts to integrate indicators of economic growth based on innovation, technology research, and knowledge with the indicators of quality of life. The research collected data at the macro-economic level from the Republic of Slovenia between 1990 and 2011 and empirically verified individual variables based on the quality of life and economic growth. The main purpose of the research was to conceptualize and empirically verify individual variables based on the quality of life and company success, using a sample of 288 economic companies at the micro-economic level. Their innovation–government mechanisms and innovation–innovative process show a strong correlation, while technology research, innovation, knowledge, and company's success show a medium-strong correlation with the quality of life at the micro-economic level. Technology research, knowledge, and economic growth also show a strong correlation with the quality of life at the macro-economic level in the Republic of Slovenia. Company's success and economic growth in the Republic of Slovenia have a positive effect on the quality of life. The scientific contribution is based on the application of the new QL-TRIK model that investigates how economic growth fuels quality of life through technology research, innovation, and knowledge.

Keywords: *Economic growth, innovation, knowledge, technology research, quality of life.*

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Introduction

For decades, various researchers (Stiglitz, 2009, Mars, 1994, Allard, 1973, Vintar Mally, 2010, Hanžek, 2010 & Suvorov et al., 2010) have asked various questions. For example, is the growth of the economy, which is left to the market, the best or only way of humanity? Does gross domestic product (GDP) growth cause only negligible side effects on the environment and society due to uncontrolled growth? Does quality of life (QL) depend on maximizing the production of material goods?

Technology research (TR), innovation, and knowledge are pursuant to which the state should constitute a dynamic, competitive economy, with greater economic knowledge, education, and innovation. They have a supportive impact on the economic growth of transition economies, such as the Republic of Slovenia (RS). A strong correlation exists among science, technology, and income. Only high technological innovation and potential entrepreneurship have a significant impact on economic growth (Costa Ribeiro et al., 2010; Poh et al., 2005). A concrete impact has not been clearly defined.

Without quality information, it is impossible to fulfill the law of requisite holism when it comes to quality of life. Only indirect indicators are feasible. Because the development is complex, the data on material wealth as well as the growth of gross domestic product and gross national product are insufficient. We concentrate on the mechanisms of innovation and knowledge that link GDP with the purpose of better quality of life without harming the environment (Rasic et al., 2011).

Regarding other empirical and theoretical research, growth models have often not been proved to be satisfactory as the statistics are often incomplete and misleading (e.g., a lack of measure of soft indicators). None of the empirical analyses have sufficiently confirmed the theoretical bases nor given sufficient useful conclusions. One of the main reasons for such evolutionary development of the theory of economic growth is the fact that, to date, economic theory has not been able to satisfactorily—with indicators and more directly in view of the success of management—define knowledge as a factor of production. This represents a need to define new indicators, such as the need for information bases.

The problem on which we focus in this research is using comprehensive data to determine a measurable level of development of the QL and the influence of TR, innovation (including entrepreneurship), and knowledge (including knowledge of diffusion and marketing) in terms of economic growth. The purpose of the research is to design a new model of indicators useful for a more comprehensive measure of the QL and, therefore, to promote innovation, TR, and knowledge to enhance economic growth (without being destructive to the natural conditions of human life and other parts of nature) in RS—namely, the Quality of Life–

Indicators of the Technology Research, Innovation and Knowledge (QL-TRICK)—so that it supports QL, not just GDP. We want to find out how to ensure the necessary and sufficient integrity to measure the impact and relationship among the areas of innovation, such as the characteristics and technology invention, innovation diffusion process (IIDP), TR, and technology (T) knowledge on economic growth of RS for the purpose of achieving a better QL.

Using the indicators of methodological reporting and the methodology of the European Innovation Scoreboard (European Innovation Scoreboard, 2009), the European Innovation Report 2008-2010 (Hollanders & van Cruysen, 2008), it is hypothesized that it will be possible to achieve a better, more comprehensive and innovative strategy of national innovation policy transition economies and enhance the usability of TR, innovation, and knowledge in the practice of companies in transition economies (European Commission, 2010).

The variables we operationalized in the empirical part of the research were formed in the relevant scientific literature on innovation, TR and knowledge, theories of economic growth, and the QL. We seek to verify the following hypotheses in our research.

H1: Economic growth and company success are not sufficient to raise quality of life.
H2: A company's success has a positive effect on the quality of life.
H3: Economic growth has a positive effect on the quality of life.

The next chapter is based on the theory of the specific fields of TR, innovation, knowledge, and QL of company success and economic growth. First, we defined variables of indicators of TR, innovation, knowledge, company success, and QL at the micro-economic level of RS. We then defined variables of indicators of TR, innovation, knowledge, economic growth, and QL at the macro-economic level of RS. After we collected primary statistical data via a questionnaire on the micro-economic level of RS and secondary statistical data for RS between 1990 and 2011 at the macro-economic level, we used SPSS for statistical analysis. We verified hypothesis H1 with a correlation analysis and hypotheses H2 and H3 with regression analyses (see chapter: Data analysis). After testing the hypotheses, we designed the QL-TRIK model at the micro- and macro-economic levels of RS (Figure 1 and Figure 2) based on the results of the correlation and regression analyses. The most important indicators in economic practice, a summary of the correlation analysis results at the micro- and macro-economic levels of

RS, and regression analysis are summarized in Table 8. A discussion and conclusions are provided in the last chapter of the paper.

Literature on quality of life and economic growth fuelled by technology research, innovation, and knowledge

Theory, development strategies and policies are, during a global crisis, concentrated on one issue: whether the GDP measures development. GDP as an indicator of development has already been reviewed (Hanžek, 2010, Murn, 2010, Plut, 2010, Stiglitz, 2009 &Tome, 2010), and the results have indicated the need to replace it—or at least supplement it—with a better rate of development.

The high rate of growth since World War II has been based on the belief that growth enhances the pride of the country, even though high-growth companies are not happier (Cassiers, 2011). In the last two centuries, the population and the quantity and quality of production have increased. If the world economy continues to grow at the same rate, by 2100 it will be 80 times higher (Jackson, 2009: 13; Seljak, 2000: 6). What is the nature of this growth and what are the real needs and for whom? In addition to economic indicators, the country needs other indicators to measure social development (QL), explaining the situation and development of the individual companies.

Based on the holistically sustainable education and the associated revised hierarchy of values, the integrated indicators measuring human and ecosystem well-being and quality of life (rather than just GDP) are indispensable building blocks for the implementation of a sustainable paradigm (Plut, 2010: 20). However, complete totality is not possible, so we have the law of requisite holism (Mulej & Kajzer, 1998).

Korten et al. (2011), within the New Economy working group, found that it is necessary to measure GDP, indices of shares, and other financial indicators, which have hitherto been a key objective measurement of economic activity, in order to replace indicators related to health, social, and economic factors as well as the ecological integrity of the QL. GDP measures only the monetary value of trade in goods and services in the market. It does not tell us much about QL, the community in which we live, or the natural system. The leading countries that have thus far measured the growth of GDP have not brought people to a better QL, reduced the release of gases into the environment, or minimized other environmental issues. A higher GDP indicates that the U.S., despite higher unemployment and poverty, is achieving economic growth. Focusing on the economy with a view to raise GDP is needed to shift to the use of indicators such as health and community factors as well as the achievement of the economic impact at the local and global levels. GDP has many shortcomings in the measurement of QL. The accelerated depletion of valuable natural resources like oil accelerates GDP growth; even causing the destruction of the natural resources on which it depends can lead to GDP growth. Daly, in Farley (2010), asserted that GDP actually measures the cost of production, which aims for QL but leads to social disaster.

Economic growth does not improve QL, but rather the availability of public goods, services (e.g., education), infrastructure, and public health and ecosystem services (Constanza, Farley, & Kubiszewski, 2010; Plut, 2010). We need a development concept and method of optimal economic and social development for quality of life: The concept takes into account the natural balance and restrictions (better performance) and, therefore, should not be based on continuous, maximum quantity growth (Plut, 2010).

Hicks (2012) found that, in our rapidly changing society, QL requires adequate new approaches. Subjective well-being measurement needs to supplement existing objective measures as well as various social indicators. The study of the relationship between subjective quality of life and income shows that average life satisfaction is higher in countries with greater GDP per capita. Income plays an important role in influencing quality of life: As countries experience economic growth, their citizens' life satisfaction typically grows (Sacks, Wolfers, & Stevenson, 2010), but this is not without limits: After a threshold, non-economic factors become increasingly important (Šarotar Žižek, 2012). Andrews (1974) found that human well-being not only leads to economic growth, but the state must play an active role in ensuring the well-being and to have instruments to measure well-being.

We are living through the worst financial, economic, and social crisis in post-war history. The EC has recommended reforms in the measurement of economic growth (Stiglitz et al., 2009), but such reforms would also be desirable even if there was no crisis. Modern economics is at an important turning point paradigm. Yet some members of the commission believe that the crisis increases the urgency of these reforms. One reason for this is that the existing system of measurement is not appropriate due to an improper set of statistical indicators. Current indicators of the economy are considered to be effective measurements, but the consequences now show that we did not cover content relevant to today's situation, but the former, who have passed. Among them, for example, the GDP tells a lot about the extent of market operations, rather than the conservation of natural living conditions of the present civilization on the effects of business for people, especially for their happiness, on the social responsibility of governments, businesses, and people to both people and nature. Economy is not an end to itself, but to the people. Technological research and development should contribute to the invention innovation diffusion process (IIDP). Innovation is one of the sources of pleasant well-being and people's happiness, even in the form of supporting economic growth and development, without having to destroy the natural conditions of human life—or at least not as much as during the last two centuries. Economic growth in itself does not increase happiness. Even China, with the highest rate of economic growth, has shown no improvement in life satisfaction. Full employment and safety net policies increase happiness (Easterlin, 2012).

The criteria of economic growth should be able to help remove such tendencies; otherwise people will resolve the issues themselves. The question is: Which indicators tell what is essentially intended to grow until no longer aimed only at commercial scale operations, meaning that it in itself helps narrowly understand economic success and does not take into account the complexity of humanity (Šarotar Žižek, Mulej, & Treven, 2009)? This fact does not diminish the importance of TR, knowledge, technological work IIDP (TIIDP), or innovation; rather, it raises the question of what their content is and how to measure—or at least reasonably assess—their impact, success, and other consequences. Does this mean that, for example the RS—as a typical transition country moving from the routine of life to an innovative economy—underinvest in innovation, TR, and knowledge, thereby disabling and preventing the success of technological work for IIDP? Another question relates to the extent to which the implementation of TR in terms of content, as measured by indicators, helps monitor these problematic consequences when it comes to natural conditions for the existence of the present civilization of mankind (e.g., Korten, 2009; Taylor, 2008). Howart (2012: 38) argued that accepting substantial reductions in the future rate of economic growth might be unnecessary for safeguarding and sustaining the biophysical systems that provide the basis and underpinnings for humans' livelihoods and well-being. Significant growth in GDP, a measure of the subjective value of goods and services, cannot be achieved in the interim by moving to technologies and consumption patterns sufficient to sharply reduce the economy's "ecological footprint."

Methodology

Research is based on defining a system of indicators in the field of TR, innovation, knowledge, and economic growth to enhance QL. It is a complex process. The proposed models (Figure 1 and Figure 2) verify whether the application of indicators for individual variables at the micro- and macro-economic levels, as shown by theoretical research, was correct and meaningful.

Non-technological innovation IIDP was not included in the research; nor were the values, culture, ethics and norms, even if they were considered to be influential when it comes to TR, innovation, TIIDP and knowledge. We are not measuring the economic productivity, but QL, as a result of structural changes, which characterizes the evolution of the modern economy. Such limitations were used to model the impact of certain factors, for which we determined the intensity of their impact on QL. The restrictions also limited access to primary data in an empirical survey as well as the breadth and scope of indicators in terms of accessibility acquisition of secondary data (statistics data). The verification of the hypotheses was also limited due to the intensity of changes in financial, economic, and social crises. The aspect of market conditions was also taken into account. Hypotheses were verified using two types of variables, which we divided according to the acquisition of primary data sources at the micro-economic level of RS (companies) and secondary data sources at the macro-economic level of RS (RS national data statistics).

Data gathering

Secondary statistical data were limited to current documents of the EU and the RS that included data and information on the QL, GDP, TR, T knowledge, TIIDP, and innovation. These essentially included The World Bank (2012), WCY (2010), OECD (2010), EIS (2009), and SURS (20130, among others. This paper gathers data for RS between 1990 and 2011. The option for the macro-economic level of RS is justified by the inclusion of five scopes of different indicators (Table 1).

The primary statistical data were obtained from 1,430 respondents employed in companies of RS. In designing the study, the sample was limited by the size of the population (Zakon o gospodarskih družbah, Ur.l. RS, št. 42/2006) of the company. The units of population were spread out based on random sampling. Based on the TR, innovation, knowledge, economic growth, and QL constructs, we developed indicators and variables created in accordance with the questionnaire that altogether summarize the main features of the quantitative indicators that might capture the dimension at the macro- and micro-economic levels and growth of RS.

Data analysis

The statistical analysis was performed using the software SPSS (Statistical Package for the Social Sciences Statistics, version 19.0). The research aimed to verify Hypothesis H1 using correlation analysis and Hypotheses H2 and H3 using regression analysis.

Through the correlation analysis, we discovered the links between the characteristics of representative variables and determined the intensity of the connection or correlation between TR, innovation, knowledge, and QL and the success of companies at the micro-economic level as well as the intensity of the connection or correlation between TR, innovation, knowledge, and QL and economic growth at the macro-level in RS. We then constructed the QL-TRICK (H1) model at the micro-economic level (Figure 1) and economic growth at the macro-level (Figure 2).

We used regression analysis at the micro-economic level of RS to determine the influence of the success of companies in RS on QL (H2) and, at the macro-economic level, the impact of the economic growth of RS on QL (H3). Through the regression analysis, we wanted to examine the effect of companies' performance on the QL and the impact of economic growth on the QL. First, we defined variables for factor analysis because we wanted to explain a maximum of variability. The conditions for the execution of the factor analysis and determination of the factors were to verify the correlation among sets of dependent variables. Before carrying out the factor analysis, we examined the suitability of the information for using this method. In the first step, we conducted Bartlett's test of sphericity and verified the correlation between variables according to the level of significance of less than 0.05. We then conducted the Keiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test and measured data for factor analysis. The KMO measure value in the present case was greater than 0.8, so we are talking about the optimal suitability of data for factor analysis. In the next step, we conducted the factor analysis using the Principal Axis Factoring (PAF) method, which is a widely used method in factor analysis. The basic principle of the PAF method is to maximize the variance of the common factor, but based on an estimate variance from which factors are located (Field, 2005). In PAF (Warner, 2007: 785), the analysis of the data structure focused on shared variance, not on sources of error that are unique to individual measurements. For some datasets, PC and PAF might yield similar results in terms of the number and nature of components or factors. For many applications of factor analysis in the behavioral and social sciences, the conceptual approach involved in PAF (i.e., trying to understand the shared variance in a set of X measurements through a small set of latent variables called factors) might be more convenient than the mathematically simpler PC approach (which sets out to represent all of the variance in the X variables through a small set of components).

We conducted the PAF in two steps. First, we determined the PAF method for assessing the communalities; then we used a Varimax rotation for the factor weights. The limit for the inclusion of variables in the factor model was determined at the value of communalities, or 0.40 (Field, 2005: 631). We excluded from the model any variables for which less than 40% of the variance was included in the model. For easier factor interpretation, we made a right angles matrix of factor weights after the Varimax method, where the rotated factors were independent of each other. When we saved the factor scores in the SPSS program, we defined new variables. When verifying the hypothesis of regression, we also met the criterion that the independent variables were not correlated. Factor scores were saved as new variables—namely, standard normal distributed variables—and used to test the hypothesis at the micro-economic level of RS.

In the next step, we conducted a correlation analysis (H1). The correlation analysis was based on primary data using the results of the questionnaire and on a sample of secondary data from RS (Annex A), keeping in mind the high values of correlation coefficients (correlation is significant at the 0.01 level (2-tailed)).

Empirical results

- The correlation analysis was performed with the aim of verifying Hypothesis H1: Economic growth and company success are not sufficient to raise quality of life. When considering the full range of variables, certain values of correlation coefficients were negative. If the empirical analysis revealed that independent determinants of economic growth, QL, TR, innovation, and knowledge were not able to measure and were not mutually correlated, they were not included in the regression analysis. We considered only the positively correlated variables, which were divided and named after specific areas:
- TR_A: R&D (results—technological development, financial support)
- INOV_B: results of innovation policy and innovation results
- KN_B: knowledge transfer, knowledge acquisition, and knowledge creation
- EG_B: GDP growth, investment, international economics, and macro-economic impact of GDP

- QL_B: environmental component (the balance of natural resources, energy consumption, and environmental impact due to the economy), people (population growth, the activity of the population, life expectancy, and birth), health, and HDI (human development and satisfaction)

Table 1 shows a correlation matrix on the macro-economic level of RS. TR is strongly correlated with knowledge (0.848), economic growth (0.774), and quality of life (0.813). Knowledge is strongly correlated with TR (0.848), economic growth (0.944), and quality of life (0.961). Economic growth is strongly correlated with TR (0.774), knowledge (0.944), and quality of life (0.913). Quality of life is strongly correlated with TR (0.813), knowledge (0.961), and economic growth (0.913).
Ferligoj et al. (2011: 12) defined the coefficients in the following manner:
$0.05 < \alpha < 0.3$ is a weak correlation
$0.3 \leq \alpha < 0.6$ is a medium-strong correlation
$0.6 \leq \alpha < 1$ is a strong correlation

Table 1: Correlation Matrix: Macro-economic level of RS

		TR	INOV	KN	EG	QL
TR	PKK	1				
	Sig.(2 tailed)					
	N	20				
INOV	PKK	0.276	1			
	Sig.(2 tailed)	0.3				
	N	16	16			
KN	PKK	.848(**)	.593(*)	1		
	Sig.(2 tailed)	0	0.016			
	N	20	16	22		
EG	PKK	.774(**)	.571(*)	.944(**)	1	
	Sig.(2 tailed)	0	0.021	0		
	N	20	16	22	22	
QL	PKK	.813(**)	.559(*)	.961(**)	.913(**)	1
	Sig.(2 tailed)	0	0.024	0	0	
	N	20	16	22	22	23

** Correlation is significant at the 0.01 level (2-tailed).

We noted that, at the macro-economic level, all values of correlation coefficients of the TR, innovation, knowledge, economic growth, and QL variables in the table correlation matrix (Table 2) showed positive interdependence. The darkly shaded fields in the correlation matrix show a strong correlation ($0.6 \le \alpha < 1$); lighter shaded fields in the correlation matrix show a medium or weaker correlation ($0.3 \le \alpha < 0.6$). This is significant at the ($p < 0.01$) level.

Table 2: Correlation Matrix: Micro-economic level of RS

		TR	CS	QL	INOV (GM)	INOV (IP)	KN (OC)	KN (RC)
TR	PKK	1						
	Sig. (2-tailed)							
	N	278						
CS	PKK	.372(**)	1					
	Sig. (2-tailed)	0.000						
	N	275	275					
QL	PKK	.247(**)	.522(**)	1				
	Sig. (2-tailed)	0.000	0.000					
	N	274	274	274				
INOV (GM)	PKK	.547(**)	.558(**)	.317(**)	1			
	Sig. (2-tailed)	0.000	0.000	0.000				
	N	278	275	274	278			
INOV (IP)	PKK	.511(**)	.597(**)	.369(**)	.671(**)	1		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000			
	N	278	275	274	278	278		
KN (OC)	PKK	.303(**)	.179(**)	0.117	.266(**)	.306(**)	1	
	Sig. (2-tailed)	0.000	0.003	0.053	0.000	0.000		
	N	278	275	274	278	278	278	
KN (RC)	PKK	.321(**)	.538(**)	.389(**)	.418(**)	.440(**)	.429(**)	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	
	N	278	275	274	278	278	278	278

** Correlation is significant at the 0.01 level (2-tailed).

Hypothesis H1 at the macro-economic level is confirmed. Economic growth is not sufficient to raise QL. At the macro-economic level,

indicators that shows strong relationship with QL are TR, KN, and EG (Table 3). The strong relationship among these variables indicates that some system connects them. EG shows a medium-strong correlation with INOV. At the micro-economic level, we found that indicator QL has a strong relationship with CS. No other indicators showed a connection with QL (Table 3).
The equation constructed for the verification of hypotheses was estimated using a regression analysis, alternating between two different independent variables (company success and economic growth) as the measure for quality of life at the micro- and macro-economic levels (Tables 3 and 4).

Table 3: Definition of variables: Hypothesis H2

Variable	Definition		Data source: primary data at the micro-economic level
Independent	Company success		Questionnaire
Dependent	QL	Estimated result: positive	Questionnaire

Table 4: Definition of variables: Hypothesis H3

Variable	Definition		Data source: secondary data at the macro-economic level
Independent	Economic growth		The World Bank (2012), The World Bank (2012a), WHO (2012), OECD (2012), IMF (2012), IMF (2001),
Dependent	QL	Estimated result: positive	SURS (2013), WDI (2012), Eurostat (2012), IRF (2012), and IEA (2012)

Hypothesis H2 is verified by the regression analysis, in which we verified the influence of the independent variable—namely, the success of companies (questionnaire) on the dependent variable QL at the micro-economic level. H2: Company's success has a positive effect on the quality of life.
Results of the regression analysis (Table 5) show that the regression coefficient is 0.501 and is significantly different from 0 ($p < 0.01$). The impact of economic growth on the QL is positive.
Using the *F* test shows that the resulting regression function is reliable. The value of the *F* statistic is 147.142 ($p < 0.05$). Hypothesis H2 at the micro-economic level is confirmed.

Table 5: Regression analysis (micro-economic level): Hypothesis H2

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Constant	2.132	0.177		12.052	0.000
	Company success	0.501	0.05	0.522	10.082	0.000
	Dependent Variable: QL					

Hypothesis H3 is verified by the regression analysis at the macro-economic level in RS, in which we verified the influence of the independent variable on the dependent variable QL. H3: Economic growth has a positive effect on the quality of life.
Table 5 shows that the regression coefficient is 0.921 and is significantly different from 0 ($p < 0.01$). The influence of the independent variables indicator EG on the dependent variable indicator of QL is positive. Using the *F* test shows that the resulting regression function is reliable. The value of the *F* statistics is 100.287 ($p < 0.05$). Hypothesis H3 at the macro-economic level is confirmed.

Table 6: Regression analysis (macro-economic level): Hypothesis H3

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	Constant	10.037	4.491		2.235	0.037
	EG	0.921	0.092	0.913	10.014	0.000
	Dependent Variable: QL					

Modeling the quality of life with economic growth fuelled by technology research, innovation, and knowledge (QL-TRIK): Micro- and macro-level economic growth

Using a sample of 288 companies in RS[1] surveyed at the micro-economic level, we found that, on average, they were not successful in the last two years. The previous chapter reported that, at the micro economic level, we found that the independent variable of companies' success affected the dependent variable's environmental, economic, and non-economic indicators of QL (Table 5). At the macro-economic level, we found that the independent variable of economic growth[2] positively impacts QL[3] (Table 6). In the research on the sample of surveyed companies from RS, we also found that employees placed the greatest importance on protecting the environment and concerns about the environment. We further noted that employees produce agricultural products for the purpose of their own households. Activities outside the production boundary are important because of the terms of citizens' own QL. We considered the good environmental aspect of the QL and the bad economic and non-economic aspect of the QL of employees by companies in RS. We found that economic growth is one of the key factors of the QL. It can also be argued that the success of companies is one of the factors of the RS population's satisfaction with economic and non-economic aspects of the QL (Table 2).

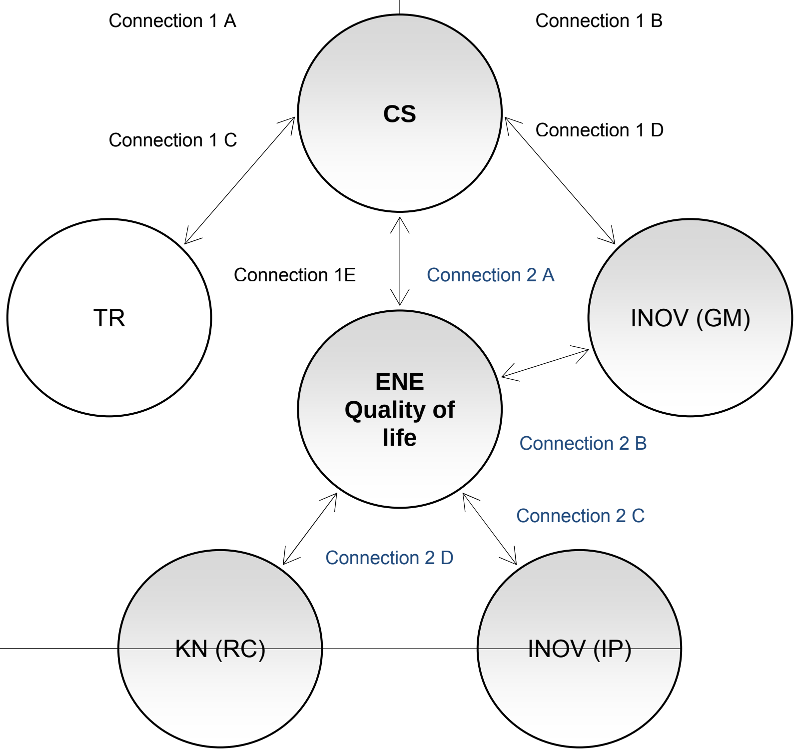
Figure 1, the graphical QL-TRIK model for the micro-level economy of RS, summarizes the correlation analysis results at the micro-level economy of RS between CS and five variables (connection 1): TR, ENE QL, INOV (GM), INOV (IP), and KN (RC). The CS variables have a medium-strong correlation on variables: TR (0.372), ENE QL (0.522), INOV (GM) (0.558), INOV (IP) (0.597), and KN (RC) (0.538). The correlation coefficients are significant at the $p < 0.01$ level.

We also summarized the correlation analysis results at the micro-level economy of RS between ENE QL and four variables (connection 2): CS, INOV (GM), INOV (IP), and KN (RC). The ENE QL variables have a medium-strong correlation on the variables: CS (0.522), INOV (GM)

[1] This includes focusing on households as the unit of analysis. The questionare included five sets of questions: technology research, innovation, knowledge, company success, and quality of life. The fifth questionairre set on QL refers to an individual household.
[2] Economic growth is defined by GDP growth, investment, international economics, and macro-economic impact of GDP.
[3] QL is defined by the environmental component (balance of natural resources, energy consumption, and environmental impact due to the economy), people (population growth, the activity of the population, life expectancy, and birth), health, and HDI (human development and satisfaction).

(0.317), INOV (IP) (0.369), and KN (RC) (0.389). The correlation coefficients are significant at the $p < 0.01$ level.

Figure 1: Graphical QL-TRIK model: Micro-level economic growth of RS



The linkage between quality of life and economic growth at the macro-level can be shown as follows (Figure 2). TR, knowledge, and economic growth are strongly related with quality of life, which consists of three elements: knowledge, economic growth, and TR. We found that economic growth at the macro-economic level in correlation with knowledge and TR is one of the key factors of the QL. TR is defined by the R&D indicator (the results of technological development and financial support), which consists of the TR_B variables (Annex A), which are interrelated indicators of knowledge (knowledge transfer, knowledge acquisition, and knowledge creation), or the KN_B variables (Annex A). TR and knowledge are the basis for economic growth. The EG_B variables (Annex A), which provide indicators of economic growth (GDP growth, investment, international economics, and macro-economic impact of GDP), are the basis for QL; environmental factors (balance of natural resources, energy consumption, and impact on the environment due to the economy), population (population growth, the activity of the population, life expectancy and birth), health, and HDI (Human Development Index and satisfaction) are indicators that describe the QL (QL_B, Annex A). The concept of the most important indicators of quality of life is discussed next (Table 7). We recognize that, beyond BDP, environmental, human, and social capital is important to consider as sustainability aspects of QL.

Figure 2: Graphical QL-TRIK model: Macro-level economic growth of RS

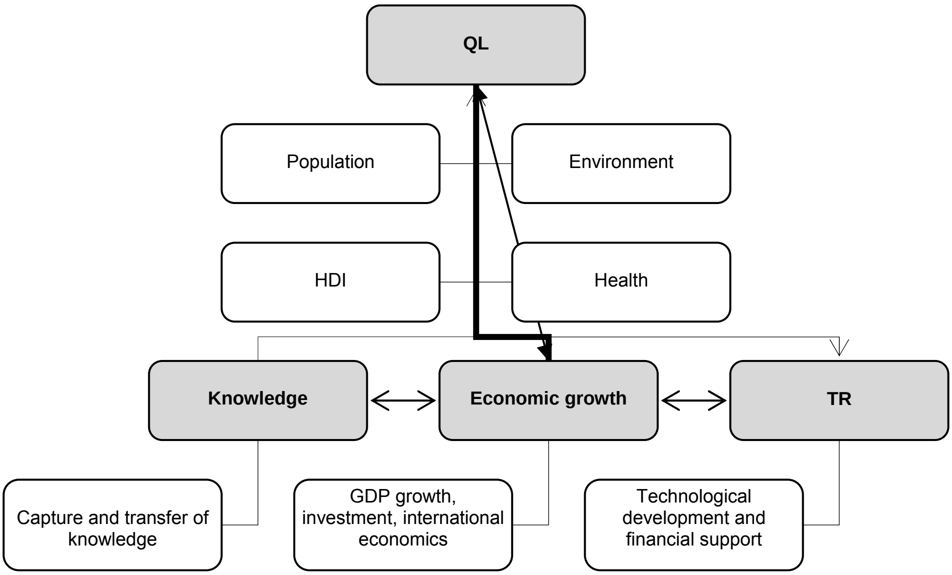


Table 7 summarizes the most important indicators in economic practices as well as the correlation analysis results at the micro- and macro-level economy of RS and regression analysis. It focuses on specific single indicators and composite indices, such as the HDI. All variables correlating with QL at the micro- (Figure 1) and macro- (Figure 2) economic level of RS and all variables for which the regression analysis (H2 and H3) showed an impact on QL were combined into a meaningful whole and divided and named according to the following key areas to achieve better QL.

Table 7: Indicators of QL

Non-economic aspects QL (variables (QL, EG_B)
Satisfaction with their own lives. Satisfaction with standard of living. The feeling of happiness. Health and well-being. Satisfaction with leisure activities. Satisfaction with social life (visits, cultural events, various forms of associations, voluntary assistance to the needy). Satisfaction with forms of travel (escape from everyday life, to learn something new or for rest, recreation, socializing). The feeling of safety (road safety, personal safety and security when using the internet). Satisfaction with the work of the police and the courts in the event of damage. Trust in state institutions. Trust in people. Human Development Index (HDI). The activity of the population. The birth rate. Lifespan. Access to healthcare and quality; the number of physicians The growth of the urban population.
Economic aspects QL (variables EG_B, CS, QL)
Satisfaction with employment. Satisfaction with housing conditions. Satisfaction with personal material situation (income, consumption, and housing). The Gini coefficient (distribution of income among the population). Railways. Roads. Air transport.
Environmental aspects QL (variables EG_B, QL)
Protection and concerns about the environment. Production of agricultural products for the purpose of his own household. CO_2 emissions. Production of cereals. Chemicals. Renewable fuels and waste. Energy consumption.
Knowledge (variables KN_B, KN (RC))
Daily newspapers. Higher education. Number of scientific and technical journal articles. Use of communication technologies (Internet, phone, cell phone).

Enterprises' projects—connection with R&D institutes and universities. Enterprises' investment in knowledge.
Innovation and TR (variables TR_B, INOV (GM), INOV (IP))
Grants, excluding technical cooperation. Expenditures on R&D in the business sector expenditures by source of funding. Innovative processes of products and services as well as marketing of innovative products and services. National mechanisms for promoting innovation and collaboration with industry.

Discussion and conclusions

This paper contributes to the current literature by presenting a new model, QL-TRIK, forming a new system of indicators for QL using the variables TR, innovation, and knowledge as well as indicators of economic growth. It was designed as a practical example containing new guidelines and suggestions on the use of statistical indicators, the requisite holistic information from them to achieve more meaningful economic growth, QL (Figure 1, Figure 2, and Table 7), and the achievement of better, easier political decision making as well as a better national innovation policy.

The application of the QL-TRIK model relies on a dialectical system of interacting variables: TRR, innovation, and knowledge as key factors in economic growth. The model focuses on promoting non-economic impacts of the QL by connecting the correct indicators of TR, innovation, and knowledge and improving the information and support for researchers, universities, and companies in terms of opportunities for investing in research, innovation, and knowledge through the structural funds and the specific programs in the interaction of the RS political system and the financing of public and private institutions in the TR, innovation, and knowledge.

Innovation is not limited to the IIDP in terms of products and services; it must be covered mainly by state administration and management. The economic situation and the political system situation of RS in the field of innovation, TIIDP, TR, and knowledge are negligible. In a transition economy, such as in RS, a crisis is considered merely as a financial or economic event, but not a climatic, natural, legal, sociological, or psychological crisis. We need to make structural changes to consumer society and consumer savings (for details, see Rasic et al., 2011).

An industrial economy, which follows the GDP, says a lot about the success and productivity and less about the happiness and sustainability of human life. GDP has often been used as a proxy measure QL because more income would allow an individual to satisfy more preferences, resulting in increased QL (Dolan, 2011). An industrial economy is focused on the scale of operations and costs. GDP as an indicator for measuring the QL was tested in this study based on the results of verifications of tested hypotheses (H1, H2, and H3) supplemented with indicators that measure other factors (TR, knowledge, and innovation) as these environmental, social, and sustainable development indicators (e.g., indicators from the EU 2020 Strategy) were developed by a number of other international institutions.

With the inclusion of new indicators it is possible to achieve a better national innovation policy, transition economies, and enhanced usability of TR, innovation, TIIDP, and T knowledge skills in terms of increased measurable indicators of the QL. But this is not necessarily sufficient for success and not necessary for the selected variables to be the most appropriate for achieving higher economic growth.

This paper gives the European Commission and the designers of the new economic policy of transition economies, such as RS, recommendations for reforms in the measurement of economic growth and the QL. The resulting question arises: What rate of economic growth and to what extent do they consider to signify growth? At the same time, to what extent are companies considered to be successful? We live in prosperity and abundance, so what will the growth in prosperity be? Since World War II, the economy has experienced a five-fold growth in GDP. By increasing the offer in the market, the economy grows, but the question is whether this results in even better QL. In achieving a five-times larger GDP, we have used seven times as many natural resources. Until 1820 (the year of the statistical industrialization), GDP growth was 3% over 1000 years. Now we are seeing a 3% GDP growth each year (Stiglitz, 2009). Stiglitz concluded that “the time was right to shift the emphasis from measuring economic production to measuring people's quality of life.” Yet the reasons for this are unrealistic because of neoliberal economics. It is essential to generate innovation for socio-economic relationships. Economic growth does not cover the costs incurred, but economic growth and financial markets depend on meeting human needs.

Resources

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Anexes

Annex A Variables of indicators of TR, innovation, knowledge, economic growth, and QL at the macro-economic level of RS

Research field	Indicators	Variables
Technology Research	TR_A	High-technology exports (% of manufactured exports) R&D expenditure (% of GDP) Researchers in R&D (per million people) Technicians in R&D (per million people) Percentage of expenditure on R&D in the business sector expenditure by source of funding (national sources) Patent applications, residents
	TR_B	Grants, excluding technical cooperation (BoP, current US$) Percentage of expenditure on R&D in the business sector expenditure by source of funding (sources from abroad) Percentage of expenditure on R&D in the business sector expenditure by source of funding (private non-profit organizations)
Innovation	INOV_A	Self-employed, total (% of total employed) Revenue from the sale of technologically active enterprises The Percentage of GDP devoted to R&D Graduate graduates - the technical direction (per 1000 inhabitants aged 20-29) Number of patents granted (USA) for marketing High-tech exports
	INOV_B	Subsidies, except for technical cooperation (current, USD) Proceeds from the sale of innovation active enterprises

		The number of employees of all innovation active enterprises Number of employees of technology companies active Number of employees of non-technological innovative enterprises Proceeds from the sale of all technological and non-technological innovative enterprises The number of employees of all technological and non-technological innovative enterprises Revenue from the sale of non-innovative enterprises Number of employees of non-innovative enterprises Number of enterprises innovation activities, the three-year Revenues (1000 EUR) from the sale of innovation activity, three-year
Knowledge	KN_A	Percentage of GDP public spending on education Expenditure on student high school (% of GDP per person) Continuing education in secondary school (%) Public funding of education, total (% of GDP) Secondary education, students generally Vocational secondary education, students Percentage of gross national income (adjusted savings, expenditure on education)
	KN_B	Daily newspapers (per 1,000 people) Internet users (per 100 people) Enrollment in private primary schools (% of total enrolled in primary school) Enrollment in high school (% of total) The number of scientific and technical journal articles Telephone lines (per 100 people) Subscriptions to mobile phones (per 100 people)
Economic Growth	EG_A	Percentage annual growth in government revenue Foreign direct investment, net inflows (% of GDP) Employment in agriculture (% of total employment) Exports of goods and services (annual% growth) GDP per capita, annual growth in% Gross domestic savings (% of GDP) Industry, value added (annual growth in %) Services, etc. value added (annual % growth) Tax revenue (% of GDP)

		Imports of goods (% of merchandise imports) Manufacturing, value added (% of GDP)
	EG_B	Electricity consumption (kWh per person) Foreign direct investment, net outflows (% of GDP) Production of electricity (kWh) Employment in Services (% total employment) Labor force participation rate, total (% of total population aged 15 years and over) Exports of goods and services (% of GDP) Fuel exports (% of merchandise origin) Imports of fuels (% of merchandise imports) Domestic companies listed on the stock exchange, together GDP per capita (constant 2000 USD value) Merchandise exports (current prices USD) Imports of goods (current prices USD) Imports of goods and services (% of GDP) Trade in goods (% of GDP) Services, etc. value added (% of GDP) Gross national expenditure (% of GDP) Health expenditure, private (% of GDP) Health expenditure, public (% of GDP) Computer, communications and other services (% of commercial service imports) Computer, communications and other services (% of commercial service exports) Trade and services (% of GDP) Hardware and transport equipment (% of value added in manufacturing)
	EG_C	Employment in industry (% of total employment) Net energy imports (% of energy use) External resources for health (% of total health expenditure) Food, beverages and tobacco (% of value added in manufacturing) National final consumption expenditure (% of GDP) Industry, value added (% of GDP) Inflation, GDP deflator (annual %) International tourism expenditure (% of total imports) International tourism receipts (% of total exports) Military expenditure (% of GDP) Military expenditure (% of government expenditure) Travel services (% of imports of services) Transport services (% of imports of services) Imports of agricultural raw materials (% of

		merchandise imports) Food imports (% of merchandise imports) Travel services (% of commercial service exports) Exports of agricultural raw materials (% of merchandise exports) Food exports (% of merchandise exports) Private capital flows, total (% of GDP) Exports of goods (% of merchandise exports)
Quality of life	QL_A	Agricultural area (% of total surface area) Agriculture, value added (% of GDP) Agriculture, value added (% annual growth) Improved water source (% of population with access) Arable land (arable land) (% of total surface area) GNI per person, annual growth in % Hospital beds (per 1,000 inhabitants) Mortality, adult , female (per 1,000 female adults) Mortality, adult , male (per 1,000 male adults) Mortality of children (in 1,000 live births) Water pollution , chemical industry (% of total emissions of organic pollutants) Water pollution, production of glass and pottery (% of total emissions of organic pollutants) Water pollution, pulp and paper production (% of total emissions of organic pollutants) Water pollution, textile industry (% of total emissions of organic pollutants) Water pollution, wood industry (% of total emissions of organic pollutants) Unemployment, total (% of total labor force) Unemployment, youth total (% of total labor force aged 15-24) Social contributions (% of revenue)
	QL_B	Air transport, passengers carried Air transport, registered number of departures, the world Birth under the supervision of qualified health personnel (% of total) CO2 emissions (tones per person) CO2 emissions caused by transport (% of total combustion) Cereal yield (kg per hectare) Chemicals (% of value added in manufacturing) Combustible renewables and waste (% of total energy) Power Consumption (kg of oil equivalent per

		person) The Gini coefficient (distribution of income among the population) Life expectancy at birth, total (years) Outpatients visits per capita Urban population (annual growth in %) Physicians (per 1,000 people) Population aged 15-64 (% of total) Population aged 65 and over (% of total) Population growth (annual in %) Railways, goods transported (million ton - km) Railways, passengers carried (million passenger per km) Roads, goods transported (million ton per km) Roads, paved (% of total roads) The active population aged 15-24, total (%) The active population, total (% of total population aged 15-64) The Human Development Index (HDI)

Abbreviations

CS: Company success
EG: Economic growth
EC European Commission
GDP: Gross Domestic Product
IIDP: Invention, innovation diffusion process
INOV (GM): Innovation (government mechanisms)
INOV (IP): Innovation (innovative process)
KN (OC): Knowledge (obstacles to reestablishing collaboration with economy)
KN (RC): Knowledge (reestablishing collaboration with economy)
RD: Research and development
QL-TRIK: The Quality of Life–Indicators of the Technology Research, Innovation and Knowledge
RS: Republic of Slovenia
T: Technology
TR: Technology Research
TIIDP: Technology invention, innovation diffusion process
ENE QL: Economic, noneconomic and environmental quality of life