

Intellectual Capital of Natural Sciences and the Efficiency of its Formation at Scientific Institutions

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Abstract: The formation of intellectual capital (IC) of natural sciences at scientific institutions (SIs) in Latvia is highly topical. The object of the research is the formation of IC of natural sciences at SIs while the subject of the research is the comparative analysis of the efficiency of the involvement of academic staff and PhD students in the formation of IC of natural sciences at SIs of Latvia. The objective of the research is to study the involvement of academic staff and PhD students in the formation of IC of natural sciences at SIs in Latvia in the period from 2013 to 2018. The following tasks were determined to reach the objective: to study the formation of IC of natural sciences at SIs; to identify the concept of the efficiency of the involvement of academic staff and PhD students in the formation of IC of natural sciences; to calculate main indicators thereof, and, to carry out the comparative analysis of indicators characterising the efficiency of the involvement of academic staff and PhD students in the formation of IC of natural sciences at SIs in Latvia. Research methods used in the paper are content analysis, economic analysis, and economic experiment.

Keywords: Intellectual Capital Indicators, Natural Sciences, Scientific Institutions, Efficiency, Academic Staff

1. Introduction

The aim of the research is to study IC of natural science and the efficiency of its formation at SIs in Latvia. Every six years, the Ministry of Education and Science of the Republic of Latvia (MoES) organises an international evaluation of SIs registered in Latvia. The last International Evaluation of Scientific Institutions' Activity (IESIA) refers to the period from 2013 to 2018. In order to establish the dynamics of efficiency indicators of academic staff involved in the formation of IC in natural science at SIs of Latvia (MoES, 2021), the authors used the output secondary data of findings across the set of evaluation of SIs of natural sciences per period from 2013 to 2018 offered by "Technopolis-group" (TG). Consequently, it provides an opportunity for the authors to calculate the efficiency indicators of IC in natural sciences at SIs of Latvia and to compare their results.

Data of the comparative analysis will help to develop support programs to increase the efficiency of involvement of the academic staff in the IC formation. In addition, the comparative analysis will reveal whether the score of natural

sciences at SIs of Latvia in the IESIA of TG coincides with the place of SIs of Latvia in the ratings of IC indicators, and whether the overall score of SIs of Latvia also reflects the efficiency of the involvement of the academic staff of SIs of Latvia in the IC formation.

Hypothesis: The overall score of SIs shows the efficiency of the IC formation at SIs of Latvia.

2. Theoretical Background

The Research of the role of human capital in educational-training process at the university (Contu, 2017) presented different aspects of IC. Spica et al (2017a) state that IC is an economic category, the spiritual value created by the human potential, and it can be accumulated and converted into the value of other capitals. By investigating certain information about the management of education and science, we can increase the capacity and significance of the country's total economic capital movement. Rondeau et al (2022) remind that peer reviewed publications remain a traditional form of academic productivity. Spica et al (2017a; 2017b) have worked out four indicators of the efficiency of the formation of IC in the higher education establishment (HEE): (1)The efficiency of the involvement of academic staff in the formation of IC per year in percentages (AIK); (2)The efficiency of the involvement of academic staff with a Doctorate degree in the formation of IC per year in percentages (DIK); (3)The efficiency of the involvement of students in the formation of IC per year in percentages (SIK); (4)Mutual efficiency of the involvement members of the academic staff with Doctorate degrees and the academic staff without Doctorate degrees in the formation of IC per year in times, (DE).

3. Research Methodology

In order to calculate the AIK, DIK, SIK, and DE of the HEE Spica et al (2017a; 2017b) have worked out four formulas: (1) $AIK = (ZPS : AS) \times 100$; (2) $DIK = (ZPS : DS) \times 100$; (3) $SIK = (ZPS : SS) \times 100$; (4) $DE = DIK : AIK$. Where: ZPS represents the number of scientific publications of the HEE per year; AS represents the number of academic staff in full-time jobs per year; DS represents the number of academic staff with Doctorate degrees holding in full-time jobs per year; SS represents the number of students per year.

The authors modified the above mentioned formulas for the purposes of the study. Namely, they calculate IC efficiency indicators for total numbers of full time equivalent (FTE) academic and research personnel (KIK), for FTE academic personnel (AIK), for FTE academic and research personnel (PIK) and for PhDs completed at Sis (SIK). In addition, all the said IC efficiency indicators were calculated for different forms of IC such as total number of self-reported outputs of IC (KS), articles in peer reviewed scientific edited journals and conference proceedings included in WoS or SCOPUS (WS), articles in peer reviewed edited journals, and conference proceedings not included in WoS or SCOPUS (RS), monographs (MS), and Latvian patent (LPS), and European patent and International patents (EPS). The authors calculated mutual efficiency indicators (PE) regarding involvement of the FTE academic and research personnel (PS) and the FTE academic personnel (AS) in the formation of IC in times.

In the present research, the authors used the following data from the IESIA: output data on the number of FTE academic personnel (AS), the number of FTE academic and research personnel (PS), the total number of FTE academic and research personnel (KS), the number of PhDs completed (SS), the number of articles in peer reviewed scientific edited journals and conference proceedings included in WoS or SCOPUS (WS), the number of articles in peer reviewed scientific edited journals and conference proceedings not included in WoS or SCOPUS (RS), the number of monographs (MS), the number of Latvian patents (LPS), and the number of European and International patents (EPS), and total number of self-reported outputs (KS) in period from 2013 to 2018 per SI of natural science in Latvia. Authors revised the above WS, RS, MS, LPS, EPS and KS for the year.

To calculate the efficiency of the involvement of academic staff in the WS formation used formulas:

$$AIK = (WS : AS) \times 100 \quad (1)$$

$$PIK = (WS : PS) \times 100 \quad (2)$$

$$KIK = (WS : KS) \times 100 \quad (3)$$

$$SIK = (WS : SS) \times 100 \quad (4)$$

$$PE = PIK : AIK \quad (5)$$

In order to calculate the efficiency of the involvement of academic staff in the RS formation used formulas:

$$AIK = (RS : AS) \times 100 \quad (6)$$

$$PIK = (RS : PS) \times 100 \quad (7)$$

$$KIK = (RS : KS) \times 100 \quad (8)$$

$$SIK = (RS : SS) \times 100 \quad (9)$$

$$PE = PIK : AIK \quad (10)$$

The efficiency of the involvement of academic staff in the formation of MS calculated according to formulas:

$$AIK = (MS : AS) \times 100 \quad (11)$$

$$PIK = (MS : PS) \times 100 \quad (12)$$

$$KIK = (MS : KS) \times 100 \quad (13)$$

$$SIK = (MS : SS) \times 100 \quad (14)$$

$$PE = PIK : AIK \quad (15)$$

To calculate the efficiency of the involvement of academic staff in the formation of LPS used formulas:

$$AIK = (LPS : AS) \times 100 \quad (16)$$

$$PIK = (LPS : PS) \times 100 \quad (17)$$

$$KIK = (LPS : KS) \times 100 \quad (18)$$

$$SIK = (LPS : SS) \times 100 \quad (19)$$

$$PE = PIK : AIK \quad (20)$$

Besides, to calculate the efficiency of the involvement of academic staff in the formation of EPS used formulas:

$$AIK = (EPS : AS) \times 100 \quad (21)$$

$$PIK = (EPS : PS) \times 100 \quad (22)$$

$$KIK = (EPS : KS) \times 100 \quad (23)$$

$$SIK = (EPS : SS) \times 100 \quad (24)$$

$$PE = PIK : AIK \quad (25)$$

In this study, one scientific publication or one patent are accepted as one unit of IC. Further, using the modified formulas 1 to 25, were calculated: KIK, AIK, PIK, SIK, PE. Then, according to the results obtained through the author's calculations, a corresponding rating place was assigned to each SI of Latvia per year and each of the above indicators KIK, AIK, PIK and SIK.

Each place in the rating was then assessed with an appropriate score, where the lowest score is 1 point, while the highest score is 5 points. Thus, the SI, which took first place in - KIK, AIK, PIK and SIK received 5 points in the ranking, took second place - received 4 points, took third place - received 3 points, took fourth place - received 2 points, and took fifth to seventh place - received 1 point.

The above mentioned assessment system allows to compare the quantitative efficiency indicators of SIs of natural science in Latvia calculated by the authors to IESIA overall assessment criterion - quality of the SI research performance. The relevant TG Panel was the score of research performance of each SI using a scale where score 5 means an outstanding level of research, score 4 means a very good level of research, score 3 means a good level of research, score 2 means an adequate level of research, and score 1 means a poor level of research (MoES, 2021).

The score assigned to the overall assessment by the relevant TG Panel was based on the assessment of five sub elements A to E, where element A characterises the quality of the research, element B - the impact on the development of the specific field of science, element C - the economic and social impact of the research, element D - the research environment and infrastructure of the institution, element E - the institution development potential. The Panel was provided with scores against each sub-element and the overall score and was also provided with narrative descriptions of their scores, the overall score and the sub-elements (MoES, 2021).

The follow-up authors compared the results of their own estimates of SIs quantitative scores to the qualitative scores of the relevant TG Panel, and calculated the differences between the scores. For this purpose, the authors calculated the average score for each SI recording the efficiency indicators of the involvement of academic staff in IC formation and compared these scores to scores of the research quality of each SI and overall score developed by the TG Panel.

4. Results and Discussion

The number of scientific publications and patents are the main results of the IC formation at SIs of natural sciences. TG analysed 7 SIs of natural sciences of Latvia. In the IESIA there were collected output data on 7 public SIs of Latvia including 6 Latvian university, and one Latvian State Institute were collected.

During the period analysed in the IESIA, there were only 7 such SIs in Latvia: Latvian Institute of Aquatic Ecology, Daugavpils University (DU/LIAE); Institute of Solid State Physics, University of Latvia (ISSP); Latvian State Institute of Wood Chemistry (LSIWC); Research programme "Biology", Daugavpils University (DU/Bi); Cluster of Natural Sciences, University of Latvia (UL/N), Ventspils University of Applied Sciences Natural Sciences Research Platform (VeU/N), Research programme "Mathematics, Physics, Chemistry", Daugavpils University (DU/MPC).

It follows from the IESIA that in Latvia, 4 SIs of natural sciences have corresponding fields of science in earth and related environmental sciences, 4 SIs corresponding fields of science in physical sciences, 3 SIs corresponding fields of science in biological science, 3 SIs corresponding fields of science in chemical sciences, 2 SIs corresponding fields of science in materials engineering, 2 SIs corresponding fields of science in mathematics, and, 2 SIs corresponding fields of science in computer and information sciences. In turn, such corresponding fields of sciences as nanotechnology; chemical engineering are operated by 1 SI in each field of science.

According to the authors' estimates, from the IESIA data show that the total number of self-reported outputs of SIs of natural science in Latvia is taken in the largest proportion by the WS - 80,72%, which is followed by the RS - 15,97%, the MS - 0,88%, the LPS - 1,70%, the EPS - 0,73%.

4.1 The Efficiency of the Involvement of Academic Staff in the WS Formation at SIs of Natural Sciences

These indicators of SIs and their place in the rating of SIs of natural sciences in Latvia as well as its scores are summarized in Table 1. The table of the SIs indicators, ratings, and score was drawn up by authors. The summarized indicators show that in general, in Table 1, the figure rests in the range from 26% to 659% in respect of the SIs in Latvia. The highest indicator is SIK in the VeU/N, while the lowest indicators is PIK in the DU/LIAE. Comparing the figures collected in Table 1, the authors conclude that the AIK indicator rests in the range from 389% to 550%. The lowest KIK indicators of 27% is for the DU/LIAE, the highest KIK indicator of 128% are for the ISSP, and for the DU/Bi; the highest SIK indicator of 659% is owned by the VeU/N while the lowest SIK indicator of 179% is held by the UL/N. The PS of the SIs of natural sciences are only 0,2 times to 0,4 times efficient in the WS formation.

In Table 1, the authors created the rating and score of the SIs of natural sciences in Latvia based on the AIK, PIK, KIK, SIK indicators of the efficiency of the academic staff and PhDs involvement in the WS formation. According to the AIK indicator, the first place, and highest score is taken by the UL/N; according to the PIK indicator, the first place, and highest score is taken by the DU/Bi; according to the KIK indicators, the first place and highest score is taken also by the DU/Bi; and according to the SIK indicator the first place and highest score is taken by the VeU/N.

On the other hand, when comparing the average score of KIK without SIK, the highest score is obtained by the DU/Bi and the comparison of the average score of KIK with the SIK shows that the highest score goes also to the DU/Bi.

The authors compared the SIK indicators of all students of HEE in Latvia to SIK indicators of PhDs students of SIs of natural sciences in Latvia, and found that SIK indicators of the PhDs students were considerably higher. It follows from the study by Spica et al (2018) that the highest SIK indicators were held by Daugavpils University (1,45% in 2013) and the University of Latvia (1,82% in 2014). Meanwhile, between 2013 and 2018, the highest annual SIK indicator for PhDs students of SIs of natural sciences in Latvia was held by the VeU/N and represented 659%.

Table 1: The efficiency of the involvement of academic and research staff in the WS formation at SIs of natural sciences in Latvia per year in period from 2013 to 2018

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
DU/LIAE	0	0	0	26	7	1	27	7	1	0,5	0	239	6	1	0,7
ISSP	0	0	0	128	3	3	128	2	4	1,5	0	625	2	4	2,3
LSIWC	0	0	0	66	6	1	66	5	1	0,5	0	255	5	1	0,7

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
DU/Bi	494	2	4	173	1	5	128	1	5	4,5	0,4	578	4	2	3,7
UL/N	550	1	5	113	4	2	94	4	2	3,5	0,2	179	7	1	2,7
VeU/N	415	3	3	74	5	1	63	6	1	2,0	0,2	659	1	5	3,0
DU/MPC	389	4	2	159	2	4	113	3	3	3,0	0,4	606	3	3	3,0
Average	733			109			95				0,2	241			

When analyzing the results obtained by SIs in the IC formation in the field of natural sciences, the same methodology was used as in the fields of social sciences, and, humanities and art sciences. Thus, the quantitative results of SIs in these fields can be compared. One of the main criteria for the quantitative evaluation of SIs is the efficiency of the involvement of the SIs academic staff in the formation of WoS and SCOPUS publications.

The comparison of the results of the three fields of science leads to conclusion that the highest score of the KIK indicator in the field of social sciences is 278% (Spica et al, 2022) while the highest score of the KIK indicator in field of natura science is 128%, and, the highest score of the KIK indicator in field of humanities and art sciences is 53% (Spica et al, 2023). In addition, it should be noted that the highest score of the KIK indicator in the field of humanities and art sciences is two times higher than 27% received by the DU/LIAE, which is the lowest score in the field of natural science.

A similar trend is observed when comparing the efficiency of the involvement PhD degree holders in the formation of WoS and SCOPUS publications in the three above-referred fields of science. Here, the highest rate of the SIK indicator in social sciences is 667% (Spica et al, 2022) while in natural sciences the highest rate is 659%, and, the highest rate of the SIK indicator in humanities and art science is 450% (Spica et al, 2023). In turn, the lowest rate of the SIK indicator in the field of natural sciences is 179%; the lowest rate of the SIK indicator in the field of social sciences is 58% (Spica et al, 2022); the lowest rate of the SIK indicator in the field of humanities and art science is 13% (Spica et al, 2023). This means that the lowest rate in the field of natural sciences, however, is almost 14 times higher than the lowest rate in the field of humanities and art science, and, almost 3 times higher than the lowest rate in the field of social sciences.

4.2 The Efficiency of the Involvement of Academic Staff in the RS, MS, LPS, EPS Formation at SIs of Natural Sciences

In Table 2, in respect of SIs of natural science in Latvia, the figure rests in the range from 1% to 165%. The highest indicator is the SIK in the LSIWC, but the lowest indicators are the PIK and the KIK in the DU/LIAE.

Table 2: The efficiency of the involvement of academic and research staff in the RS formation at SIs of natural sciences in Latvia per year in period from 2013 to 2018

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
DU/LIAE	0	0	0	1	7	1	1	7	1	0,5	0	11	7	1	0,7
ISSP	0	0	0	12	6	1	12	5	1	0,5	0	57	5	1	0,7

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
LSIWC	0	0	0	43	1	5	43	1	5	2,5	0	165	1	5	3,3
DU/Bi	116	1	5	41	2	4	30	2	4	2,0	0,4	135	2	4	2,7
UL/N	97	2	4	20	4	2	17	4	2	1,0	0,2	32	6	1	1,0
VeU/N	68	4	2	12	5	1	10	6	1	1,5	0,2	109	4	2	1,7
DU/MPC	82	3	3	34	3	3	24	3	3	3,0	0,4	128	3	3	3,0
Average	145			21			19				0,2	48			

The AIK indicators were collected only for the 4 SIs of natural sciences, and the authors conclude that the highest AIK indicator of 116% is held by the DU/Bi, while the lowest AIK indicator of 68% belongs to the VeU/N; the highest PIK indicator and KIK indicator of 43% is held by the LSIWC, while the lowest PIK indicator and KIK indicator of 1% belongs to the DU/LIAE; the highest SIK indicator of 165% is held by the LSIWC, while the lowest SIK indicator of 11% belongs to DU/LIAE.

In Table 3 the figure rests in the range from 1% to 17% in respect of the SIs in Latvia. The highest indicator is SIK in the DU/Bi and the VeU/N, but the lowest indicators are PIK and KIK in the UL/N and the DU/MPC.

Of the 7 Latvian SIs in the field of natural sciences, the 4 SIs have the MS, the 5 SIs have the LPS, and, only the 3 SIs have the EPS.

Table 3: The efficiency of the involvement of academic and research staff in the MS formation at SIs of natural sciences in Latvia per year in period from 2013 to 2018

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
DU/Bi	14	1	5	5	1	5	4	1	5	5,0	0,4	17	1	5	5,0
UL/N	7	3	3	1	4	2	1	3	3	2,5	0,2	2	4	2	2,3
VeU/N	10	2	4	2	2	4	2	2	4	4,0	0,2	17	2	4	4,0
DU/MPC	4	4	2	1	3	3	1	4	2	2,5	0,4	6	3	3	2,7
Average	8			1			1				0,2	3			

Table 4: The efficiency of the involvement of academic and research staff in the LPS formation at SIs of natural sciences in Latvia per year in period from 2013 to 2018

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
ISSP	0	0	0	1	4	2	1	4	2	1,0	0	5	3	3	1,7
LSIWC	0	0	0	6	2	4	6	2	4	2,0	0	23	2	4	2,7
DU/Bi	2	3	3	1	5	1	0	5	1	2,0	0,4	2	5	1	1,7
UL/N	9	2	4	2	3	3	2	3	3	3,5	0,2	3	4	2	3,0
DU/MPC	39	1	5	16	1	5	11	1	5	5,0	0,4	61	1	5	5,0
Average	15			2			2				0,2	5			

In Table 4 the figure rests in the range from 1% to 61% in respect of the SIs in Latvia. Comparing the figures collected in Table 4, the authors conclude that the highest AIK, PIK, KIK and SIK score is held by the DU/MPC, while the lowest AIK, PIK, KIK and SIK score belongs to the DU/Bi.

In Table 5 the figure rests in the range from 1% to 11% in respect of the SIs in Latvia; the highest PIK, KIK and SIK score is held by the LSIWC, while the lowest PIK, KIK and SIK score belongs to the UL/N.

Table 5: The efficiency of the involvement of academic and research staff in the EPS formation at SIs of natural sciences in Latvia per year in period from 2013 to 2018

SI	AIK (%)	AIK rating	AIK score	PIK (%)	PIK rating	PIK score	KIK (%)	KIK rating	KIK score	Average of AIK & PIK score	PE in times	SIK (%)	SIK rating	SIK score	Average of AIK & PIK & SIK score
ISSP	0	0	0	1	2	4	1	2	4	2,0	0	7	2	4	2,7
LSIWC	0	0	0	3	1	5	3	1	5	2,5	0	11	1	5	3,3
UL/N	4	1	5	1	3	3	1	3	3	4,0	0,2	1	3	3	3,7
Average	7			1			1				0,2	2			

In the tables from 1 to 5, the average indicators PE are the same, and the average SIK indicators are the highest, while the average KIK indicators; the average AIK indicators are the highest, while the average PIK indicators.

The comparison of the results of the three fields of science leads to conclusion that the highest average rate of the PE indicators is 1,8 (Spica et al, 2022) in social sciences, the second highest average rate of the PE indicators is 1,7 (Spica et al, 2023) in humanities and art sciences, and, the lowest average rate of the PE indicators is 0,2 in natural sciences. In addition, it should be noted that the highest average rate of the PE in the field of social sciences is nine times higher than the lowest average rate in the field of natural sciences.

4.3 The Comparison of the Results of Qualitative and Quantitative Evaluation of SIs of Natural Sciences

Table 6: The Comparison of the results of qualitative and quantitative evaluation of Latvian SIs in the field of natural sciences using the IC form for period from 2013 to 2018

SI	Quality score by TG (QTG)	Overall score by TG (OTG)	Total average score of AIK & PIK using IC form (TAAP)	Difference of score (QTG-TAAP)	Difference of score (OTG-TAAP)	Total average score of AIK & PIK & SIK using IC form (TAAPS)	Difference of score (QTG-TAAPS)	Difference of score (OTG-TAAPS)
DU/LIAE	3	3	0,5	2,5	2,5	0,7	2,3	2,3
ISSP	4	4	1,5	2,5	2,5	1,7	2,3	2,3
LSIWC	4	4	0,5	3,5	3,5	0,7	3,3	3,3
DU/Bi	3	3	4,5	-1,5	-1,5	4,0	-1,0	-1,0
UL/N	4	3	3,5	0,5	-0,5	2,7	1,3	0,3
VeU/N	3	3	1,5	1,5	1,5	2,3	0,7	0,7
DU/MPC	2	1	3,5	-1,5	-2,5	4,0	-2,0	-3,0

Table 7: The Comparison of the results of qualitative and quantitative evaluation of Latvian SIs in the field of natural sciences using the overall IC for period from 2013 to 2018

SI	Quality score by TG (QTG)	Overall score by TG (OTG)	Total average score of KIK using IC overall (TAKO)	Difference of score (QTG-TAKO)	Difference of score (OTG-TAKO)	Total average score of KIK & SIK using IC overall (TAKOS)	Difference of score (QTG-TAKOS)	Difference of score (OTG-TAKOS)
DU/LIAE	3	3	0,4	2,6	2,6	0,4	2,6	2,6
ISSP	4	4	2,2	1,8	1,8	2,3	1,7	1,7
LSIWC	4	4	3,0	1,0	1,0	3,0	1,0	1,0
DU/Bi	3	3	3,0	0,0	0,0	2,7	0,3	0,3
UL/N	4	3	2,6	1,4	0,4	2,2	1,8	0,8
VeU/N	3	3	1,2	1,8	1,8	1,7	1,3	1,3
DU/MPC	2	1	2,6	-0,6	-1,6	2,7	-0,7	-1,7

When comparing the qualitative ratings of TG group to the quantitative assessments performed by the authors, it can be concluded that they differ from minus 3,0 points to plus 3,5 points in total.

The study shows that the KIK, AIK, PIK, and SIK of SIs of natural sciences in Latvia were lower than the results compiled by the relevant TG Panel except for one to two SIs of natural sciences, and, except for the DU/Bi, where QTG, OTG, TAKO scores coincided.

5. Conclusions

The study did not result in confirmation of their hypothesis. The hypothesis is accepted *pro tem* for other branches of SIs of Latvia.

The present research includes further development of study on the contents of IC of natural sciences and the efficiency of its formation at the SIs in Latvia, performed comparative analysis characterising the Latvian SIs of natural sciences as a whole, specified the system of IC efficiency indicators and presented its quantitative interpretation.

In order to improve the quality of the IESIA of SIs of natural sciences is encouraged to supplement its methodology with quantitative analysis of IC efficiency indicators.

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