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Innovation sources of knowledge for clustering standardized field of creativity[1]

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***Abstract**: This paper presents a comparative analysis of global (ISO/IEC) and local (SRPS) knowledge sources in PDCA loop quality, with the ability to monitor innovation intensity in the standardized fields of creativity. The study refers to standardized fields of the first level of International Classification Standards (ICS1) grouped in clusters of innovation. The paper focuses on the latest trends in the knowledge sources, and trend lines of certain standardized field of higher (daily) intensity of innovation in the fields of technics and informatics: ICS1 = 25 Manufacturing engineering and ICS1 = 35 Information technologies. The aim is to monitor the intensity of knowledge innovation, trends, sources of knowledge by innovation clusters and update the knowledge base for quality improvement (on standardization platform).*

***Keywords**: knowledge sources; knowledge base (KB); trend; cluster innovation; standardization*

1. INTRODUCTION

Knowledge in education process often requires significant expenses. Therefore, establishing the mechanism or model of knowledge which will be applied in complex processes bears particular significance. However, the observation and implementation of international (ISO/IEC, [1]) and local standards (SRPS, [2]) are necessary both in education and bussiness processes. Creation of *Knowledge Base* (*KB*) provides automation solutions to the problem. *Knowledge* modelling forges a path towards the desired Information-Expert System (IES) in the PDCA *quality loop* [3]. The availability and access to knowledge sources provide more reliable basis for efficient development activities of knowledge base system, as in [4]. EFQM excellence model [5] offers an adequate frame for creation and analysis of the model for conducting *knowledge* management.

The starting point for monitoring *Knowledge Sources* Innovation is archiving information on quantity and value of the *Knowledge Sources* (KS) in all fields of creativity at the first level of (ICS1) classification. As in the paper [6] in which the clustering method was applied in one standardized field, this paper shows all fields at the first classification level (ICS1). Grouping into clusters was realized according to innovation intensity of knowledge sourses.

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1.1 Research objectives and initial hypotheses

The research gives insight into creation of *Knowlegde Base* (KB) and *Knowledge Base Systems* (KBS) in the standardized fields, according to the influencing factors for knowledge innovation, viewed from various prespectives. *KB* planning can be realized from various perspectives with the purpose to develop and apply IES, starting from *knowledge sourse.* On the basis of the defined comparative indicators, such as index of quality (Iq) and index of value (Iv), innovations are set in the observed *knowledge domains* DK1. The activities in the PDCA are analyzed.

In many scientific papers, PDCA methodology has proved to be a good example of quality development [7]. The initial hypotheses have been summarized, identified and quantified in PDCA concept, through the following questions:

1) *Plan* phase (P); Is it possible to plan resources for daily *knowledge* innovation in the specific fields on the standardization platform according to original trendlines starting from *knowledge sources*?

2) *Do* phase (D); Is it possible to define comparative indicators (indices) for all fields of creativity, in order to update *data base* and *knowledge base* in ICS1 fields?

3) *Check* phase (C); Is it possible to define clustering indices of innovation intensity at the same time in all fields of creativity?

4) *Act* phase (A); Is it possible to monitor *knowledge source* trends on the standardization platform?

1.2 Methodology and frame of research of standardized field of creativity

Methods Web research, statistical methods, multicriteria analysis and clastering have been used in the paper. Data were collected from the website of the International Organization for Standardization [1] and the National Institute for Standardization [2].

The selection and analysis of *data* have been completed in the form of clustering and determining level of innovation. Creating trends of *knowledge sourse* is followed by mathematical lines/trend relations.

Based on the frequent innovations expressed by quantities and values of *KB* units, grouping/clustering is performed according to standardization fields. According to the International Classification of Standards (ICS), all standardized fields of creativity are observed (ICS1 = 01, 03 to 99). Classified fields of the first level (ICS1) enable clustering (grouping) according to intensity of knowledge innovation into: daily, weekly, monthly and yearly clusters of innovation Clustering is closer to practical application than to theoretical and mathematical model of clustering [8]. Intensity of innovation is viewed according to the relation (1).

$$Ii_{/t} = Iqu_{/ISO/t} + Iqp_{/srps/t-1} \quad (1)$$

If:

$$Ii_{/t} > 250\text{, innovations are daily – daily cluster of innovation,} \quad (2.1)$$

$$50 < Ii_{/t} \leq 250 \text{ – cluster weekly innovation,} \quad (2.2)$$

$$12 < Ii_{/t} \leq 50 \text{ – cluster monthly innovation,} \quad (2.3)$$

$$0 < Ii_{/t} \leq 12 \text{ – cluster yearly innovation,} \quad (2.4)$$

$$Ii_{/t} = 0 \text{ – no innovation.} \quad (2.5)$$

2. RESULTS AND DISCUSSION

2.1 Resource planning for (daily) knowledge innovation – *Plan* phase (P)

A significant number of fields belong to the cluster of daily intensity of innovation, as defined in Chapter 2.3. However, global intensity of innovation is higher than the local one in a greater number of fields. The trendlines of some standardized fields of technics and informatics with daily innovation intensity have been selected from the cluster of daily innovation intensity and they have been presented: ICS1 = 25 Manufacturing engineering and ICS1 = 35 Information technologies. A number of important details and the results of comparison of *knowledge* trends have been shown. Observed were parameters of local (SRPS) and global (ISO) sources of *knowledge*.

ICS1 = 25 Manufacturing engineering. The cumulative results of the field ICS1 = 25, for ISO and SRPS standards have been graphically presented both through the reveiw and trends of standardization:

a) including time-aspect of the research period, according to the year of publication, (ΣIv/year), from 2005 to early 2015, with a significant number of new projects in various stages of development (Iqu), Fig. 1a, and

b) trendlines (linear and polynomial) according to the data from the previous five years, and the created relations Iv/y_{ICS1}, Fig. 1b.

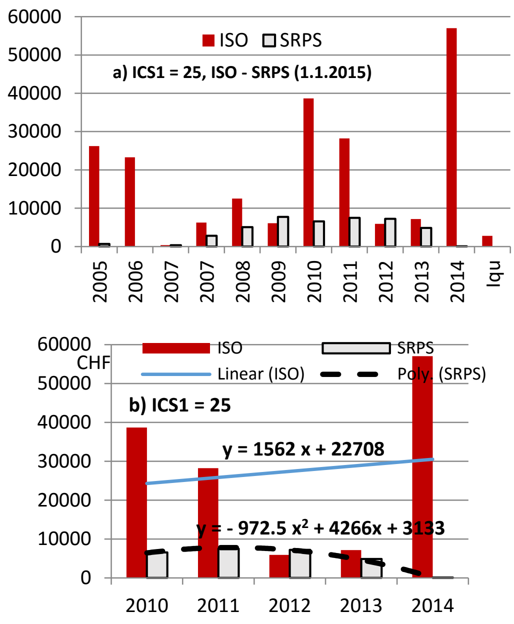

Figure 1. *Comparative analysis (ISO – SRPS) of knowledge source for ICS1 = 25 (Manufacturing engineering): a) Analysis of summary results, b) Analysis of trend lines*

$$Iv/y_{/25/ISO/2010\text{-}2014} = 1562\,x + 22708 \quad (3)$$

$$Iv/y_{/25/SRPS/2010\text{-}2014} = -972.5\,x^2 + 4266\,x + 3133$$

(4)

A linear function (Fig. 1b) determines the growing needs trend on platform ISO standardization, which, according to relation (3) is $Iv/y_{/25/ISO/2015}$ = 32080 CHF in 2015.

ICS1 = 35 Information technologies. Analysed field of creativity classified through 12 standardization subfielsds (ICS2 = 35.xyz): 35.020 Generalities, 35.040 Protection, 35.060 Languages, 35.080 Software, 35.100 OSI, 35.110 Networking, 35.140 Graphics, 35.160 Microprocessor, 35.180 Peripheral, 35.200 Interfaces, 35.220 Memory, 35.240 Applications of IT.

The cumulative results of the field ICS1 = 35, for ISO and SRPS standards have been graphically presented through the review and trends of standardization:

a) including time-aspect of the research period according to the year of publishing, (ΣIv/year), from 2005 to early 2015, with a significant number of new projects in various stages of development (Iqu), Fig. 2a and and

b) trendlines (linear, logarithmic and polynomial) according to the data from the previous five years (Fig. 2b) and the created relations Iv/y_{ICS1}, (5) and (6):

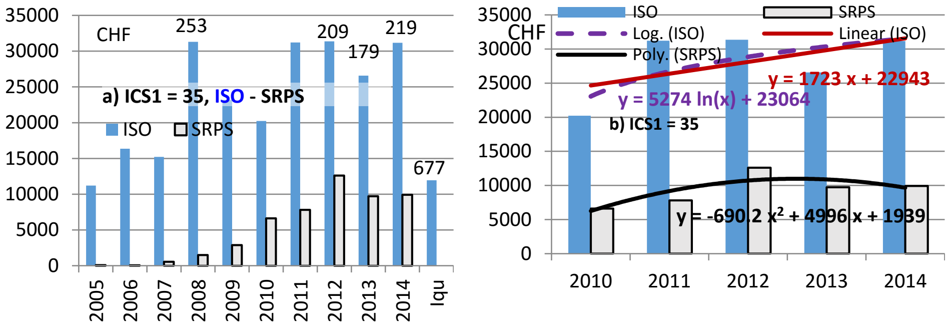

Figure 2. *Comparative analysis of knowledge source (ISO – SRPS) for ICS1 = 35 (2015.1.1): a) cumulative results, b) trends*

$$Iv/y_{/35/ISO/2010\text{-}2014} = 1723\,x + 22943 \quad (5)$$

$$Iv/y_{/35/SRPS/2010\text{-}2014} = -690.2\,x^2 + 4996\,x + 1939 \quad (6)$$

Given $Iqu_{/35/ISO/2014} > Iqu_{/35/ISO/2013}$, linear function (Fig 2b) specifies a growing needs trend, which, based on relation (5) amounts to $Iv/y_{/35/ISO/2015}$ = 33281 CHF in 2015, on platform ISO standardization. On platform SRPS standardization needs trend according to relation (6) amounts to $Iv/y_{/35/SRPS/2015}$ = 7067.8 CHF in 2015.

2.2 Comparative indexes number – *Do* phase (D)

The survey of the global (ISO) and lokal (SRPS) innovation index – Ii, is given in Table 1 (columns (6) and (7)), respectively *knowledge sources* (KS) fields of clusters daily intensity innovation. The measure of innovation is expressed through indices of quantity – Iq (columns (3) i (4)) and indices of the value – Iv, in CHF (columns (8) i (9)). Featured is the approximate ratio CHF = 100 RSD.

Table 1. *Indices of quantity and value ISO – SRPS (for fields of daily intensity, 2015/01)*

N	Field	Samples (KS)		$Iqp_{/SRPS}$	$Ii_{/2015}$		Iv	
		$Iqs_{/ISO}$	$Iqs_{/SRPS}$		$Iqp_{/SRPS/2014}$	$Iqu_{/ISO/2015}$	$Ivis_{/ISO/2014}$	$\sum Iv_{/ISO/1.1.2015}$
	ICS1	ISO	SRPS	SRPS	SRPS	ISO	ISO	ISO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
1.	01	2764	1218	899	88	218	5258	112860

2.	03	1078	541	410	82	188	7786	58376
3.	11	2130	1089	869	91	250	2712	74990
4.	13	2848	2863	2368	196	380	12028	154706
5.	23	1981	1588	1154	108	164	3474	75558
6.	25	4069	2423	1855	165	271	57040	275950
7.	35	6771	1721	1527	239	677	31172	365216
8.	49	1099	2344	2273	151	110	2740	49642
9.	75	1258	1070	793	103	161	4646	60640
10.	77	2061	1612	1084	101	152	5076	61716
11.	83	2876	1039	772	139	194	6816	71848
12.	91	1478	2823	2243	279	155	6512	66280

2.3 Creating clusters according to innovation intensity – *Check* phase (C)

According to the cumulative indices (indicators) of relations (1), as well as according to the clustering criterion (2.1), clusters with the greatest (daily) intensity of innovation are the following fields (Table 2).

Table 2. *Cluster fields with the highest (daily) intensity of innovation – ranking list*

N	ICS1	**Ii**	**Name of field**
1.	**35**	**916**	Information technology;
2.	**13**	**576**	Enviroment; Health protection; Security;
3.	**25**	**436**	Manufacturing engineering;
4.	**91**	**434**	Construction materials and building;
5.	**11**	**341**	Health care technology;
6.	**83**	**333**	Rubber and plastic industries;
7.	**01**	**306**	Generalities; Terminology; Standardization; Documentation;
8.	**23**	**272**	Fluid systems and components for general use;
9.	**03**	**270**	Services; Company organization, management and quality; Administration; Transport; Sociology;
10.	**75**	**264**	Petroleum and related technologies;
11.	**49**	**261**	Aircraft and space vehicle engineering;
12.	**77**	**253**	Metallurgy.

According to the intensity of innovation (1) and criteria (2.2-2.5) followed by the rest of the clusters (fields):

• Cluster weekly intensity of innovation, according to (1) and the criterion (2.2), belong to the following fields: ICS1 = 17 Metrology and measurement; Phisical phenomena; 19 – Testing, 21 – Mechanical systems and components for general use, 27 – Energy and heat transfer engineering, 29 – Electrical engineering, 31 – Electronics, 33 – Telecommunications. Audio and video engineering; 37 – Image technology, 43 – Road vehicles engineering; 47 – Shipbuilding and marine structures, 53 – Materials handling equipment, 55 – Packaging and distribution of goods, 59 – Textile and leather technology; 61 – Clothing industry, 65 – Agriculture, 67 – Food technology, 71 – Chemical technology, 79 – Wood technology, 81 – Glass and ceramics industries, 87 – Paint and colour industries, 93 – Civil engineering, 97 – Domestic and commercial equipment. Entertainment. Sports;

• Cluster monthly intensity of innovation (according to relation (1) and the criterion (2.3)) belong to the following fields: ICS1 = 07 – Mathematics. Natural sciences, 39 – Precision mechanics. Jewellery, 73 – Mining and minerals, 85 – Paper technology;

• Cluster annual intensity of innovation (relation (1) and criterion (2.4)) belong to two areas: ICS1 = 45 – Railway engineering and 95 – Military engineering.

Fields without innovations (relation (1), criterion (2.5)) do not exist within the first level of classification (ICS1) on an annual basis.

2.4 Monitoring trends of knowlegde source on standardization platform–*Act* phase (A)

Figure 3 presents the possibility to continuously and quantitatively monitor intensity of knowledge innovation, i.e. knowledge source trend on the standardization platform.

The results in the analyzed fields of daily cluster of innovation intensity in domain knowledge DK1 confirm the initial hypotheses by conducting the above mentioned research objectives in PDCA concept, and lead towards knowledge base systems, i.e. integration of several systems.

2.5 Discussion of the results of the PDCA

(P) Resourse Planning for Knowledge Innovation (daily, weekly or montly)

Bearing in mind the previosly presented trend analysis of the knowledge sources (Figs. 1 and 2), i.e. original trendlines, planning resources is possible on the basis of quantitative reviews of intensity of innovation (Table 2). As in the fields with daily intensity of innovation (weekly, monthly or yearly), it is also possible to plan resources based on trendlines, starting from knowledge source, in all fields of lower intensity of innovation.

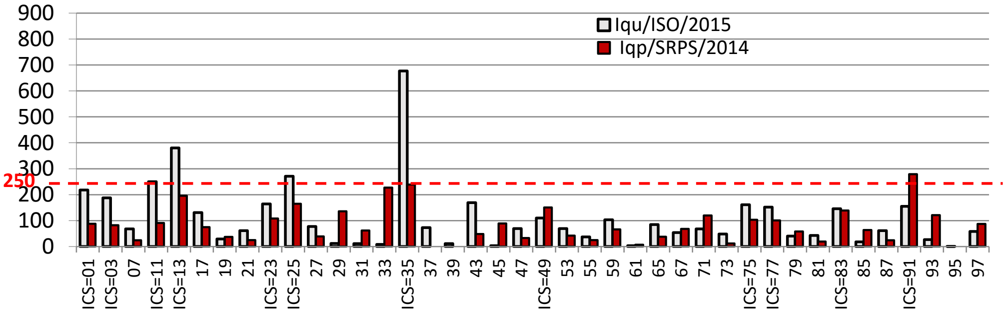

Figure 3. *Comparative review of quantities innovation ISO – SRPS sources of knowledge*

(D) Update of database and knowledge base in ICS1 fields

According to relations (3)-(6), for field *Information technologies* (ICS1 = 35) annual value $Iv/y_{/35/ISO/2014}$ = 33281 CHF. Value is comparable to other fields. For *Manufacturing engineering* (ICS1 = 25), the value amounts to $Iv/y_{/25/ISO/2015}$ = 32080 CHF. According to index of value, it is possible to plan resources for daily innovation of knowledge base, i.e. update of data base, with the aim of monitoring trends of knowledge innovation for improvement of quality product.

(C) Defining clustering indices, according to innovation intensity

Index $Ii_{/t}$, relation (1), determines the level of innovation intensity and it is assigned the values of periodical research checks (*Check* phase) for the use in practice (yearly, monthly, weekly or daily). By applying PDCA methodology, trend of knowledge innovation is checked and the future resources and financial demands in the standardized fields of creativity can be predicted, as well as innovation of knowledge base for users.

(A) Monitoring innovation trends for knowledge improvement on the standardization platform

As for the fields with the highest innovation intensity (ICS1 = 35) we determined and analysed the growing needs trend, $Iv/y_{/35/ISO/2015}$ = 33281 CHF in 2015, relation (5). By improvimg KB, predicting and providing resources, and developing information-expert system, trend of knowledge source can be monitored in all fields of creativity (ICS1 = 01, 03 to 99), on the standardization platform (Fig. 3). Thus, knowledge base can be developed by predicting and providing resources for KBS.

3. CONCLUDING REMARKS

On the basis of the results, the analysis and the proposed clustering methodology for all fields of creativity (according to ICS), the conclusions can be inferred in PDCA loop quality or in entirety, from many perspectives, with the purpose to develop IES. The conclusions are given according to the set hypotheses, respectively:

- Starting from *Knowledge Source (KS),* it is possible to plan resources for daily knowledge innovation in all ICS1 fields according to the original trendlines. The applied methodology, presented research results in KS trends and the analyzed fields of clusters of daily innovation intensity present an original, practical and safe method for determining the possibility of planning resources;
- On the basis of index parameters (index of quantity and index of value), significant and manageable possibilities to update data base and knowledge base occur in all ICS1 fields. This enables monitoring of trends of *knowledge* innovation for product quality improvement;
- The possibility to quantitatively determine clustering indices of innovation intensity is a prerequisite for grouping fields of creativity – clusters. Based on global (ISO) and local (SRPS) indices of innovation (of clustering), planned checks can be completed in all ICS1 fields of creativity, as well as innovation of knowledge base towards KBS;
- In *product* innovation, trends of knowledge innovation can be systematically and continuously monitor on the standardization platform by improving knowledge base into system – KBS. This can be achieved by predicting and providing resources, knowledge modelling, and development and application of Information-Expert System.

From the previously mentioned, we can conclude that in each PDCA cycle the application of IES brings forth improvement and expension of knowledge and availability of resources, aimed at solving problems in the target domain.

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