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DEVELOPMENT OF THE KNOWLEDGE BASE FOR APPLICATIONS OF INFORMATION-EXPERT SYSTEMS IN THE FIELD OF FOOD TECHNOLOGY

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Abstract: This paper presents a comparative analysis of global (ISO) and local (SRPS) Knowledge Sources (KS) in PDCA (Plan – Do – Check – Act) loop quality, with the ability to monitor innovation intensity in the standardized fields. The study refers to fields of the first and second levels of International Classification Standards (ICS) grouped in clusters of innovation. The paper focuses on the latest trends in the KS, trend lines of certain standardized fields, and intensity of innovation in the field of Food technology (ICS1 = 67) and sub-field Beverages (ICS2 = 67.160). The aim is to monitor the intensity of knowledge innovation, trends, KS and update the Knowledge Base (KB) for applications of Information-Expert System (IES) in ICS fields and quality improvement on the standardization platform.

Keywords: application, beverages, Food technology, Information-Expert System (IES), Knowledge Base (KB)

Introduction

Knowledge in the education process often requires significant expenses. Therefore, establishing the mechanism or model of knowledge that will be applied in complex processes bears particular significance. However, the observation and implementation of international (ISO) and local standards (SRPS) are necessary both in education and business processes (ISO, Standards Catalogue ICS). The creation of a Knowledge Base (KB) provides automation solutions to the problem. Knowledge modeling forges a path toward the desired Information-Expert System (IES) in the PDCA loop (Micic et al., 2013).

The research gives insight into the creation of KB for Knowledge Base System (KBS) in the standardized fields/sub-fields, according to the influencing factors for knowledge innovation, viewed from various perspectives. Development of the KB in the field of Food technology can be realized to

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develop IES, starting from Knowledge Source (KS). Based on the defined comparative indicators, such as the index of quality (Iq) and index of value (Iv), innovations are set in the observed knowledge domains (DK).

According to the International Classification of Standards (ICS), all standardized fields are observed (ICS1 = 01, 03 to 99), (ISO, Standards Catalogue ICS, 2024). One of the fields is Food technology (ICS1 = 67) and one of the sub-fields of Food technology is Beverages (ICS2 = 67.160). This sub-field includes the product with the most potential on the market – non-alcoholic beer with *Ganoderma lucidum* extract (Castro-Muñoz, 2019). Strong alcoholic beverages are obtained by alcoholic fermentation from plant raw materials containing sugar or starch, or they are obtained by mixing extracts, essences, and water with ethanol. According to the ethanol content, they can be divided into weak (beer, wine, sake), medium strength (vermouth, prosecco, cherry, amaro, liqueurs), and strong (brandy, whiskey, vodka, gin, rum, cognac).

According to the production process, there are differences between alcoholic beverages that are produced without the application of distillation and those that are produced with the application of distillation beer and wine are produced without applying distillation, and they contain 5 to 15% vol ethanol (Pantović et al., 2020). The application of the beverages produced is judged by the consumers to have new, pleasant, and interesting tastes and color, or good sensory characteristics (Wasser, 2011). The activities and the initial hypotheses in this paper are analyzed in the PDCA concept, through the questions:

1) Plan – Do phases – Is it possible to define comparative indicators (indices) of all ICS fields, to update KB in fields of Food technology and
2) Check – Act phase – Is it possible to define clustering indices of innovation intensity to monitor KS trends of Food technology on the ICS platform?

Standardized knowledge sources in the field of Food technology

Nowadays, the educational process in most higher education institutions also relies on innovative technologies. Regardless of the field in which IES is applied, the use of IT standards is necessary. Standardization is necessary at both levels, global (International Standards, ISO – International Organization for Standardization) and local (National Standards – SRPS). Standardization refers to the connection of knowledge that would lead to the identification of potential differences and the establishment of measures for improvement (Micić and Ružičić, 2016). Innovations (ISO and SRPS) of all fields of the ICS1 classification (time series of KS on 1st January 2015) shows that the weekly innovation cluster ($Ii/t = 3$, for $50 < \Delta KS_{DK/t} \leq 250$) belongs to a large number of fields, Figure 1 (Ružičić, 2018). Figure 1 shows 40 hierarchically organized fields of standardization covered by the ICS platform. ICS is a hierarchical classification consisting of three levels (ISS, 2023).

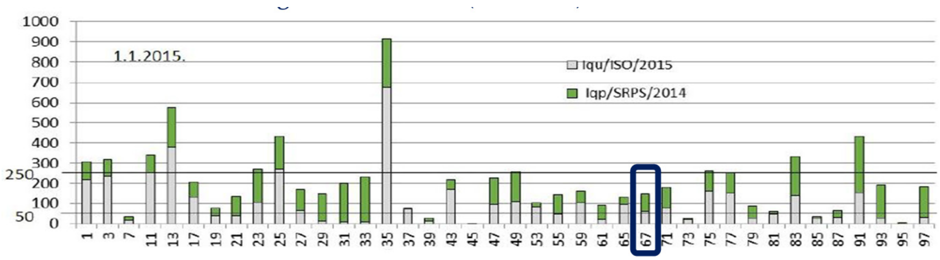

Figure 1. Analysis (ISO – SRPS) of the innovations of the weekly cluster

Materials and methods

The paper used methods of web research, statistical methods, multicriteria analysis, clustering, and surveying. Data were collected from the website of the International Organization for Standardization (ISO, Standards Catalogue ICS) and the National Institute for Standardization (ISS, 2023). The selection and analysis of data have been completed in the form of clustering and determining the level of innovation. Creating trends of KS is followed by mathematical relations (Ružičić and Micić, 2017). Based on $Iqu_{/ISO}$ and $Iqp/_{SRPS}$ and innovativeness intensity Ii/t, it is determined to which innovativeness cluster a field belongs. Based on the frequent innovations expressed by quantities and values of KB units, clustering is performed according to ICS fields (Micić and Ružičić, 2016). The intensity of innovation is viewed according to the rel. (1).

$$\Delta KS_{DK/t} = Iqu_{/ISO/t} + Iqp_{/SRPS/t-1} \quad (1)$$

If: $Ii/t > 250$, innovations are daily – daily cluster of innovation (2.1)

$50 < \Delta KS_{DK/t} \leq 250$ – cluster weekly innovation (2.2)

$12 < \Delta KS_{DK/t} \leq 50$ – cluster monthly innovation (2.3)

$0 < \Delta KS_{DK/t} \leq 12$ – cluster yearly innovation (2.4)

$\Delta KS_{DK/t} = 0$ – no innovation. (2.5)

The questionnaire was organized to identify the level of knowledge about the application of IES when teaching students of the Food Technology Study program at the Academic Studies of Faculty of Agriculture in Čačak and the Information Technology Study program at the Academic Studies Faculty of Technical Sciences Čačak, the University of Kragujevac. The research it was conducted during the winter semester of the 2023/2024 school year, in December 2023, participated 52 students in all years of study. The research tends to investigate whether the IES implementation in the educational process has a positive impact on gaining knowledge and motivating an increase of students and users in the field of Food technology, and sub-field Beverages.

Results and discussion

The analysis includes monitoring the frequency of innovativeness in the fields of knowledge and its sources, trends, knowledge of each expert as well as KB updating (Table 1), (ISO, Standards Catalogue ICS). The first level (ICS1) covers 40 fields of activity in standardization. According to relation (2.2) field Food technology is a cluster of weekly innovation ($\Delta KS_{ICS1=67/} = 144$), Table 1.

Table 1. Standardized fields cluster of weekly innovation, ranking list from

	ICS1	$\Delta KS_{/2013}$	Standardization Fileds
1	71	170	Chemical technology
2	67	144	Food technology
3	65	117	Agriculture

The field of Food technology (ICS1=67) has the next sub-fields of ICS2 (ISO, Standards Catalogue ICS, 2024): 67.020 Processes in the food industry, 67.040 Food products in general, 67.050 General methods of tests and analysis for food, 67.060 Cereals, pulses and derived products, 67.080 Fruits. Vegetables, 67.100 Milk and milk products, 67.120 Meat, meat products and other animal produce, 67.140 Tea. Coffee. Cocoa, 67.160 Beverages, 67.180 Sugar. Sugar products. Starch, 67.190 Chocolate 67.200 Edible oils and fats. Oilseeds, 67.220 Spices and condiments. Food additives, 67.230 Prepackaged and prepared foods, 67.240 Sensory analysis 67.250 Materials and articles in contact with foodstuffs, 67.260 Plants and equipment for the food industry. In the example of the field of Food technology (ICS1 = 67), the creation of a hierarchy of objects (framework) for the formation of rules and the initial KB of the model was demonstrated (Figure 2).

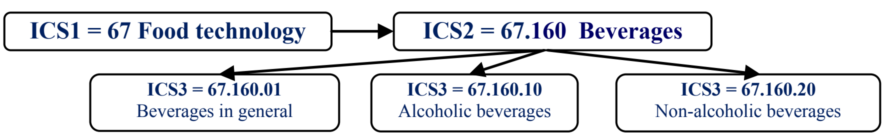

Figure 2. Creation of objects/framework for KB of IES – Food technology

The results of the ICS fields (ISO and SRPS) have been graphically presented both through the review and weekly cluster which belongs to Food technology on the ICS platform (Figure 1, Table 1, relations (1), (2.1)–(2.5)), but the results of research on the need implementation IES in the educational process (Ružičić, 2021), are presented in Table 2. The results show that more than half of the respondents (54.17%) think the IES application ensures more efficient knowledge transfer. Discussion on the PDCA concept:

- (P) Resource Planning for Knowledge Innovation (daily, weekly, or monthly)
- (D) Update of database and KB in Food technology and sub-fields
- (C) Defining clusters according to innovativeness in Food technology
- (A) Monitoring innovation of Food technology for knowledge improvement.

Table 2. Results of the conducted research

Questions	**Answers**		
	Yes (%)	**No (%)**	**I don’t know (%)**
1. Do you think that the motivation of the user to apply the innovative Information-Expert System (IES) to enable more efficient knowledge transfer in the fields of Food technology?	69.17	19.72	11.11
2. Does the user's ability to apply IES affect the understanding of the material and the student's satisfaction?	81.22	9.41	9.37
3. Using IES for the clear and precise presentation of the topics in the fields of Food technology and requirements by the users.	86.21	2.59	11.20
4. The IES application is intended for additional explanations and to help students promote their motivation and satisfaction.	90.21	4.34	5.45
5. Presented rules of the knowledge base (KB) to ensure further development and application of IES in special fields such as alcoholic beverages.	76.58	5.22	18.2
6. The IES application ensures the improvement of knowledge in the field of Food technology.	54.17	30.56	15.27

Conclusion

The results of the research show that the IES application ensures the improvement of knowledge in the field of Food technology in the educational process since it positively affects users as well as knowledge acquisition and their performance. The results of the analysis of innovation of the KB and KBS of the local (SRPS) platform utilizing the PDCA/t concept led to the achievement of the objectives of excellence in practice. Based on the analysis of the results, the conclusions can be inferred in PDCA loop quality or entirety:

1. (P–D) Based on $Iqu_{/ISO}$ and $Iqp_{/SRPS}$ and Ii/t it is determined which cluster of innovativeness belongs ICS field and
2. (C–A) It is possible to monitor knowledge source trends of fields of Food technology on the standardization platform, with the purpose of develop IES.

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