

# Development of a Procedure for Forming Recommendations to Updating the University's Variable Courses Based on Their Indicator of Selection Trends

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## Abstract

The aim of this article is to development of a procedure for forming recommendations to updating the university's variable courses. This makes it possible to predict students' choice of variable courses and study load for the structural units of the university. The article proposes a procedure for forming recommendations to updating variable courses. It is determined that it consists of an algorithm for determining the indicator of trends in the variable courses choice in accordance with the interest over time of popular search queries on the Internet and an algorithm for generating recommendations to updating variable courses. The article found that the indicator of trends in the choice of a variable course is the sum of the relevant indicators of interest with the time of search queries and/or related queries on the Internet. The paper proposes standard recommendations to updating variable courses. Its based on the value of the indicator of trends in these courses choice. Three groups of standard recommendations to updating variable courses in accordance with the value of the trends indicator in these courses choice. The main typical recommendations are the compliance of the variable course (*Recomendation<sub>I</sub>*), partial update of the variable course (*Recomendation<sub>II</sub>*), complete update of the variable course (*Recomendation<sub>III</sub>*). The article contains an analysis of interest rates over time and a quantitative analysis of the variable courses choice by the Lviv Polytechnic National University students according to the quantitative choice of 2019-2021. The study results are used and can be used for effective planning of educational services by university.

## Keywords 1

Variable courses, selection trends indicator, standard recommendation, interest over time, search query, related search query.

## 1. Introduction

The primary professional development of students occurs during their studies at the university. Educational and professional training programs for specialties include cycles of applicants' general and vocational training for educational services. Also, the structure of the educational and professional training program allows students to independently adjust the professional development direction and choose additional subjects to study, taking into account their individual and professional interests. The main elective courses advantages of professional and practical training are the possibility in-depth training in specialties / specializations, in accordance with the future activities nature within the basic specialty. This allows to form the competencies of the applicant in accordance with current trends in the labor market.

The rapid pace of modern society informatization has a significant impact on the necessary knowledge, skills and abilities for students' perceptions. That will suit them in their professional

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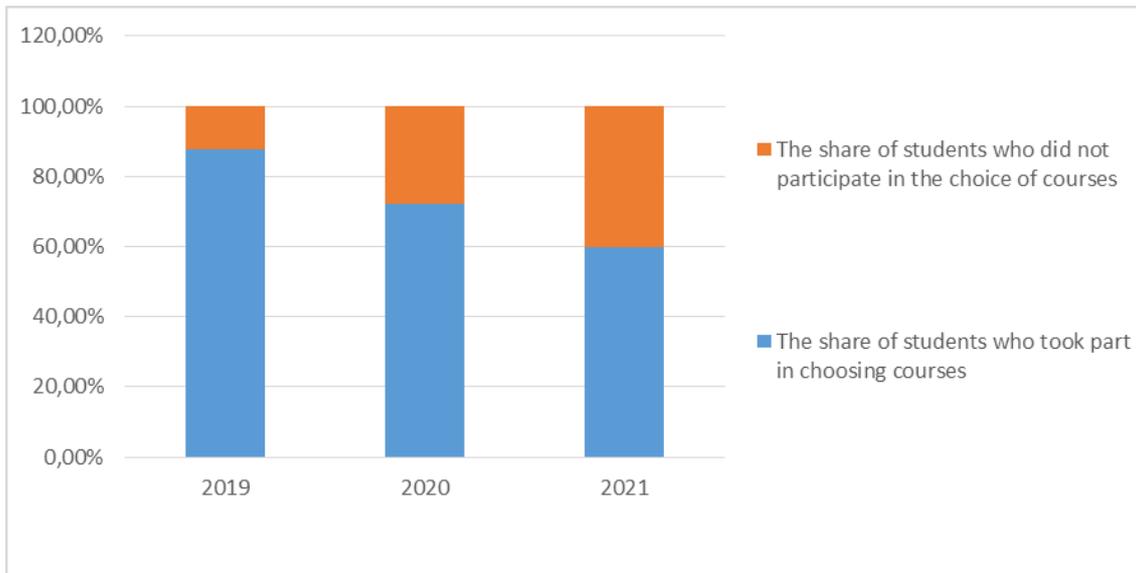
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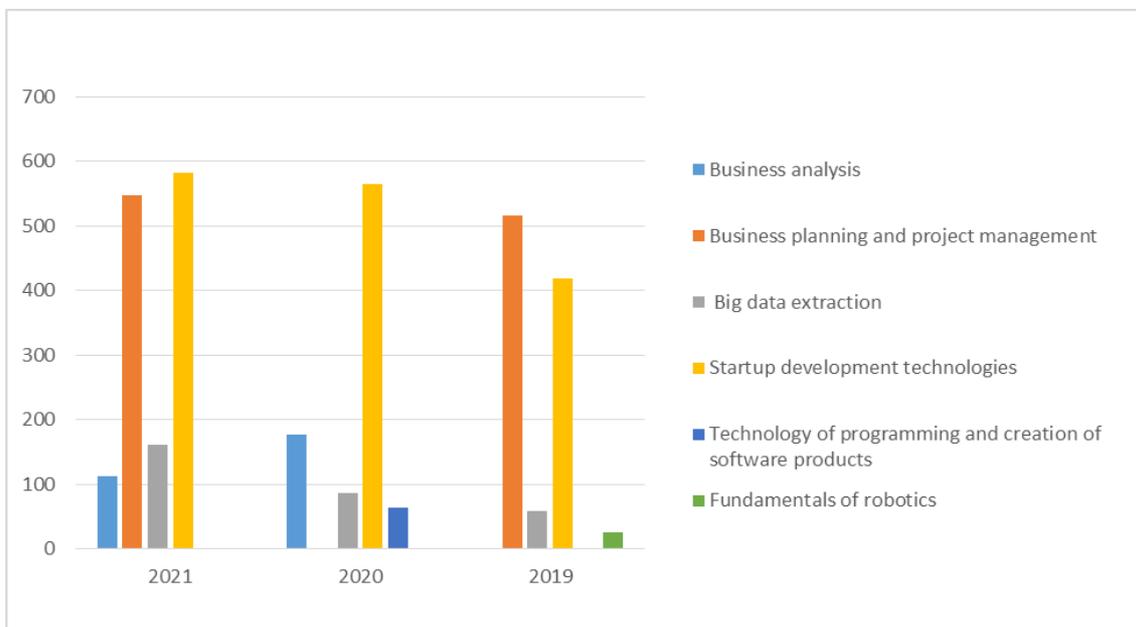
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activities. This, in turn, is directly involved in the students' decision-making process regarding the choice of additional variable courses to study at the university.

The choosing different courses process by students takes place in advance, as it directly affects the amount of study load in the university's scientific and pedagogical staff. But the process of choosing variable courses is characterized by a certain passivity of educational services' consumers. The analysis of the choosing variable courses process for 2019-2021 years at Lviv Polytechnic National University shows a decrease in the direct participation of students in the variable courses choice (see Figure 1).



**Figure 1:** Analysis of the choosing variable courses process for 2019-2021 at Lviv Polytechnic National University



**Figure 2:** Analysis of the popular variable courses choice in 2019-2021 at Lviv Polytechnic National University

In particular, in 2021 the share of students who did not participate in the variable courses choice reached 40%. Courses selected analysis at Lviv Polytechnic National University's students in 2019-2021 years shows that most popular selected courses are directly related to the professional

development of educational services consumers and take into account popular trends in training in modern conditions. In particular, Figure 2 shows the choice of the most popular variable courses by the Institute of Computer Science and Information Technology students at Lviv Polytechnic National University.

But the choice of variable courses is not always conscious and thorough in professional development. This is due in particular to the lack of professional experience, age and psychological characteristics of educational services' consumers. The titles of variable courses are not always completely clear to students in the context of the basic knowledge, skills and abilities that a student can acquire. Therefore, with the development of the professional sphere and changes in the modern labor market, there is a need to adapt and update some variable courses that students do not choose, or choose in small numbers.

Thus, the analysis of the process of choosing variable courses by students at the Lviv Polytechnic National University for 2019-2021 shows the need for additional information to educational services consumers about basic knowledge, skills and abilities of certain variational subjects that are not popular among university's students. This will allow for the adaptation of selective courses to current trends in the labor market and the qualitative formation of educational services consumers professional competencies. That is why the procedures development for the recommendations formation for updating / adaptation of variable courses in university is the purpose in this article.

## 2. Related works

The process of choosing variable courses by university students concerns different research areas. The interaction between gender stereotypes and life values as factors in choosing a profession is the subject of research [1] Researches [2-3] has established that individual differences in cognitive abilities and motivation are influenced by broader sociocultural factors. The influence of career guidance days and the importance of additional informatization in the field of professional activity for university students is considered in [4].

The study [5] identified an integrated analysis of school students' aspirations for STEM careers. Determining the factors influencing students' choice of profession is the research subject [6-9]. In particular, the study [10] established the results of the artificial intelligence influence on the certain professions by students choice. Foreign experience in choosing professional qualities by students is considered in [11].

Research [12] highlights the impact of Internet trends on career decisions by university students. In particular, the role of online counseling by a higher education institution was revealed in the work [13]. The impact of the Covid-19 pandemic on student identification is considered in studies [14-15]. Linguistic bases of decision making are the subject of research [16-19]. In particular, the data model for analysis and decision-making is considered in work [20].

But none of the studies considers the possibility of forming standard recommendations to updating the variable courses, taking into account Internet trends in the university students professional development choice. Therefore, the purpose of this study is to develop procedures for establishing the variable course popularity to form further model recommendations for their updating based on the course choice indicator trends. This confirms the relevance of this study.

## 3. Typical recommendations for updating the university's variable courses

According to the study [16], a variable course is characterized by its name, the number of ECTS credits, the name of the institute / department that provides teaching of this discipline, as well as a set of knowledge, skills and competencies provided by the competencies for the training program.

Thus, the variable course is a tuple:

$$VarCourse_i = \langle TitleVarCourse_i, CreditECTS, Department/Institution, KnowledgeSkills \rangle, \quad (1)$$

where  $TitleVarCourse_i$  is the variable course's title of the i-th specialty,  $CreditECTS$  is the number of credits allocated for course in the curriculum,  $Department/Institution$  is the subdivision of the HEI,

which provides teaching course, *Knowledge&Skills* are the knowledge, skills and abilities. services after studying course.

First of all, students pay attention to courses that characterize new trends in certain professions, identifying appropriate subject markers in the course title, and, as a rule, are not interested in the availability of courses relevant information content according to consumers professional needs of educational programs. In formulating recommendations for updating variable courses, it is worth paying attention to the formulation of the name and relevant knowledge, skills and abilities that educational services consumers will acquire in the popular trends context in the modern world labor market.

Each title and variable courses description is the subject of its comparison with world trends in various professional fields. The quickest way to do this is to compare the variable courses title with search queries or related links on the Internet. This forms the value of the trends indicator in the variable course choice in accordance with Internet trends.

Thus, the indicator of trends in the variable course choice is the sum of the relevant time interest indicators of search queries and / or the corresponding related search queries.

Therefore, we can distinguish three groups to variable courses titles correspondence to the degree of variable courses correspondence.

Group I are courses whose choice trends indicator in which belong to the interval (0.7; 1). These are the courses whose titles most accurately reflect global trends in the labor market and closely related to the search queries contained in the these courses title. These variable courses most closely correspond to modern popular directions of professional development for the educational services consumer.

Group II are courses whose selection trends indicator belong to the intermediate (0.5; 0.7). The titles of these courses are not exactly worded, so they need further clarification among educational services consumers. These courses also require a slight update of the knowledge, skills and abilities described in the competencies for this specialty.

Group III are courses whose selection trends indicator belong to the interval (0; 0.5). These courses largely do not take into account current trends, which are characterized by search queries on the World Wide Web.

Recommendations for individual groups of variable courses correspondence are a subset of specific actions on the university part.

The formation of standard recommendations for the variable courses renewal is based on the analysis of the university students' choice quantitative indicators of these courses.

Therefore, the main recommendations include:

- variable course with compliance;
- variable course with partial update;
- variable course with complete update.

Variable course with compliance is a sign that the title and basic knowledge and skills of this discipline correspond to popular professional tendencies. This course is popular among university students and usually does not need updating.

Variable course with partial update involves reformulating the course title, or rethinking the knowledge, skills and abilities described in the variable course syllabus.

A complete course means update a revision of the whole educational variable course concept.

Typical recommendations for updating variable courses are given in Table 1.

**Table 1**  
Typical recommendations for updating variable courses

Recomendation	<i>Recomendation<sub>I</sub></i>	<i>Recomendation<sub>II</sub></i>	<i>Recomendation<sub>III</sub></i>
Variable course with compliance			
Variable course with partial update			
Variable course with complete update			

#### 4. The procedure for forming recommendations to updating the university variable courses on the basis trends indicator of their choice

The procedure for forming recommendations to updating a variable courses consists of an algorithm for determining the trends indicator of variable courses' choice in accordance with popular search queries on the Internet and an algorithm for generating recommendations for updating variable courses.

The algorithm for determining the trends indicator of variable courses' choice according to popular search queries on the Internet is based on the sum of the popularity of keywords and relevant popular queries contained in the courses name.

Algorithm for determining the trends indicator of a variable courses' choice in accordance with popular search queries on the Internet is shown in Figure 3.

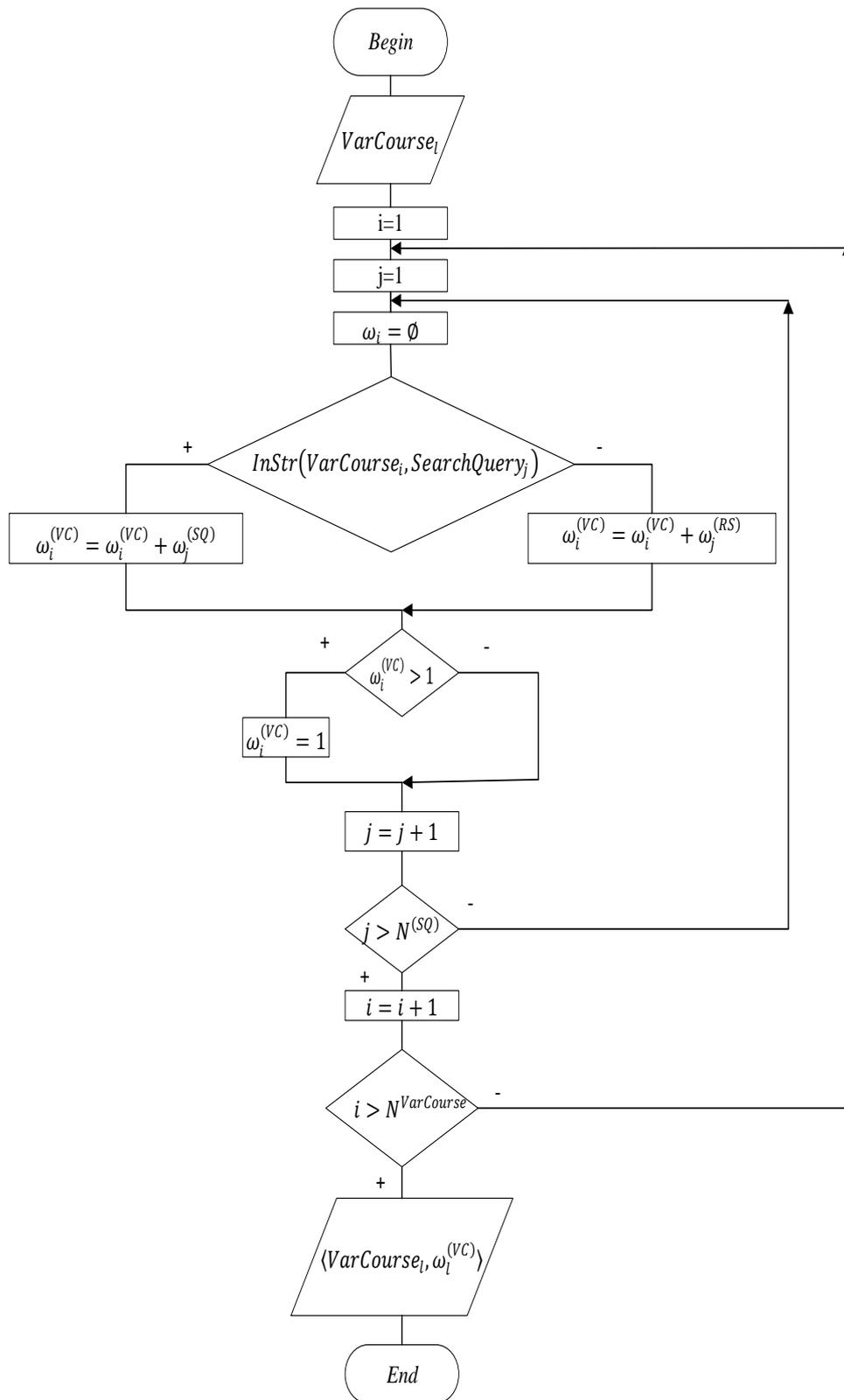
The algorithm for determining the trends indicator of variable courses' choice according to popular search queries on the Internet contains the following steps:

1. For each  $VarCourse_i$  is determine the indicator of choice trends  $\omega_i^{(VC)} = \emptyset$
2. In the title of the selective course we are looking for a relevant search query  $InStr(VarCourse_i, SearchQuery_j)$ , where  $i = \overline{1, N^{VarCourse}}$ ,  $j = \overline{1, N^{SQ}}$ .
3. If there is such a correspondence, then the trends indicator of this variable courses' choice is assigned the value of the interest over time indicator of the search query  $\omega_i^{(VC)} = \omega_i^{(VC)} + \omega_j^{(SQ)}$ .
4. If there is no search query, then we determine the trends indicator of this variable courses' choice, taking into account the values of the corresponding interest rate values of time-related search queries  $\omega_i^{(VC)} = \omega_i^{(VC)} + \omega_j^{(RS)}$ , where  $i = \overline{1, N^{VarCourse}}$ ,  $j = \overline{1, N^{SQ}}$ .
5. If the trend of choosing the variable course title is greater than 1 ( $\omega_i^{(VC)} > 1$ ), then we give it meaning 1 ( $\omega_i^{(VC)} = 1$ ).
6. To analyze the relevance of the following search query to the variational course title  $j = j + 1, = \overline{1, N^{RS}}$  and perform item 1.
7. For each subsequent variable course  $i = i + 1, i = \overline{1, N^{VarCourse}}$ .
8. As a result of the procedure for determining the trends indicator of variable courses' choice, we obtain a variable course tuple and the corresponding indicators of trends values in the courses choice.

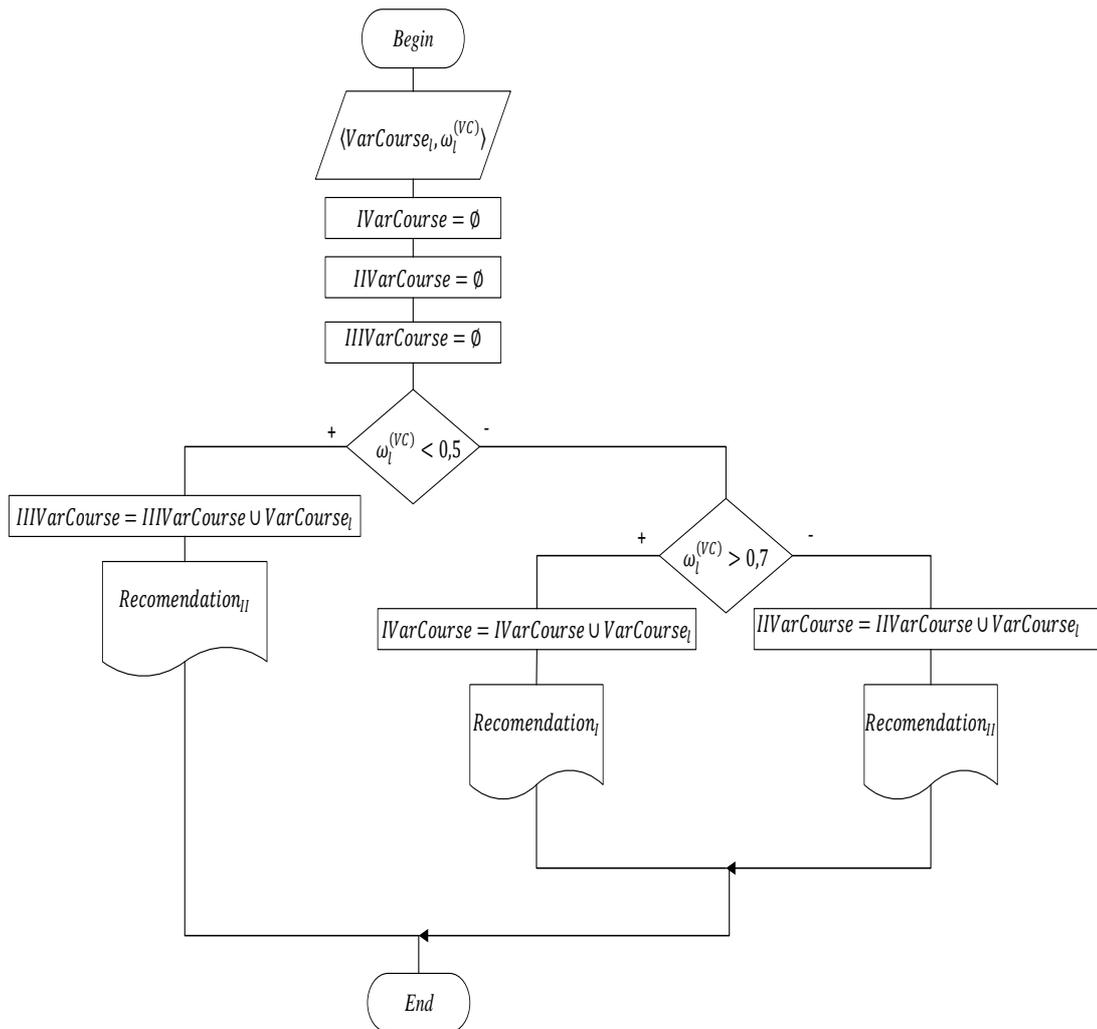
The algorithm for forming recommendations to updating variable courses at the university is presented in Figure 4.

The algorithm for forming recommendations to updating variable courses at the university contains the following steps:

1. Sets the popularity of disciplines are empty:  $IVarCourse = \emptyset, IIVarCourse = \emptyset, IIIVarCourse = \emptyset$ .
2. For a certain variable course  $VarCourse_i$ , and the corresponding trends indicator of variable courses' choice  $\omega_i^{(VC)}$  check the affiliation of this indicator to determining the recommendations intervals.
3. If  $\omega_i^{(VC)} < 0,5$ , then the value of the selection trend indicator belongs to the interval  $[0,0,5)$ . This course belongs to the set of popularity  $IIIVarCourse$  and standard recommendations  $Recomendation_{III}$  are defined for it.
4. If  $\omega_i^{(VC)} > 0,7$ , then the value of the selection trend indicator belongs to the interval  $(0,7,1]$ . This course belongs to the set of popularity  $IIVarCourse$  and standard recommendations  $Recomendation_I$  are defined for it.
5. Otherwise, the value of the selection trends indicator belongs to the interval  $(0,5,0,7)$ . This course belongs to the set of popularity  $IVarCourse$  and standard recommendations  $Recomendation_I$  are defined for it.



**Figure 3:** Algorithm for determining the trends indicator of variable courses' choice in accordance with popular search queries on the Internet



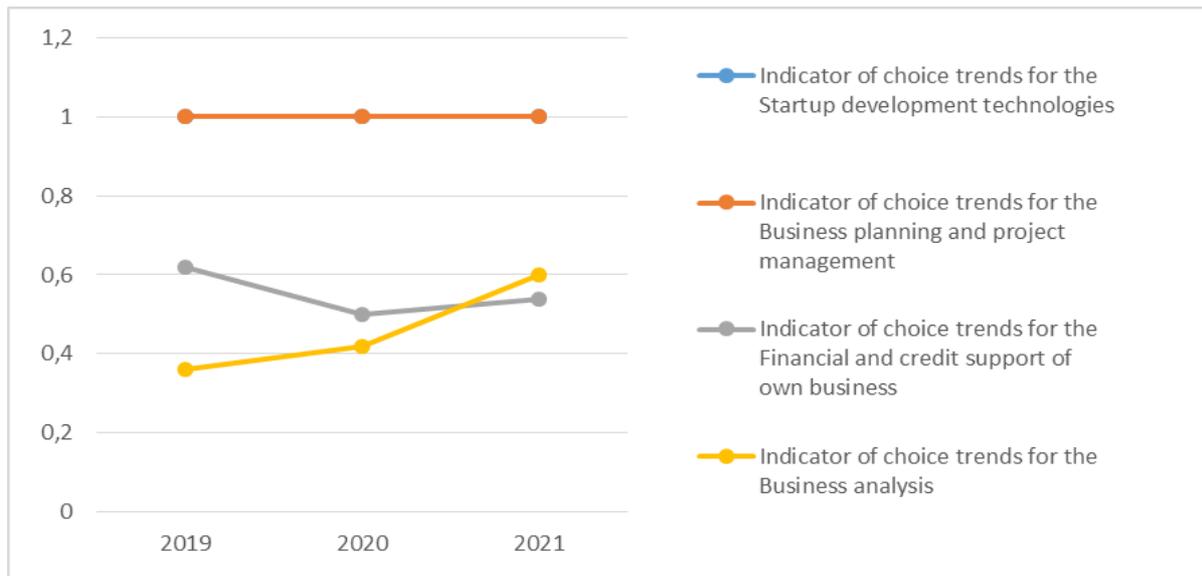
**Figure 4:** Algorithm for forming recommendations to updating variable courses at the university

The proposed algorithms allow to development a procedure for the formation of standard recommendations based on the value of the trends indicator of variable courses' choice.

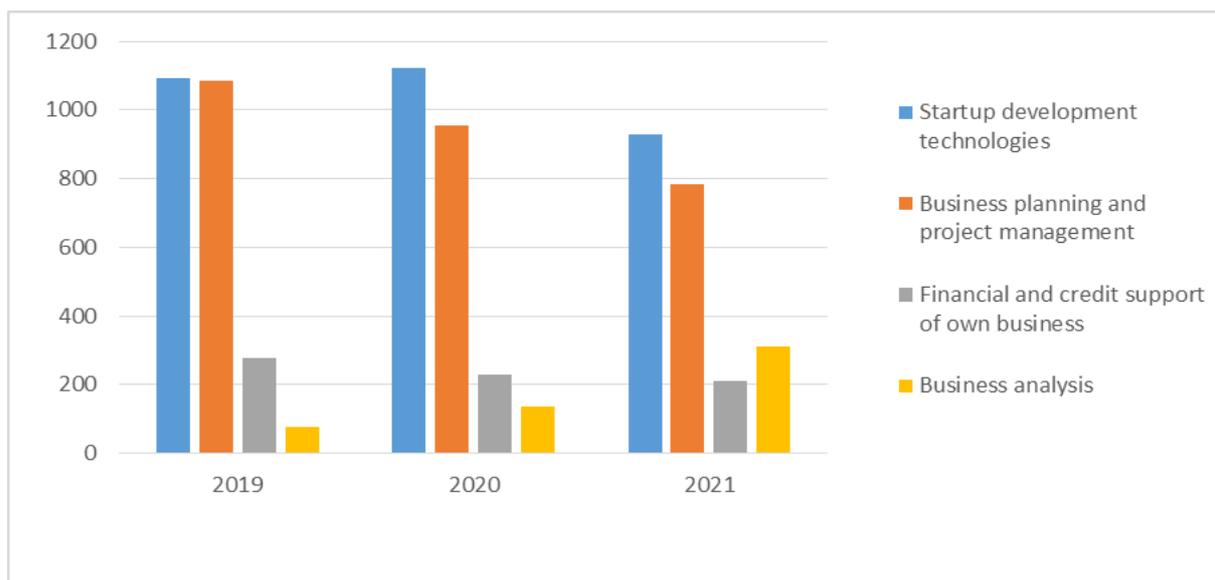
## 5. Results

Determining the trends indicator of variable courses' choice and the formation of relevant recommendations is based on the total indicator of interest over time of the relevant search queries and their related queries. Interest rates over time show the popularity of a search term relative to the highest value over a time period. Moreover, 100 is the peak of the term's popularity; 50 means that the popularity of the term is twice less; 0 means that data on this term was insufficient. Determining the interest rate over time is carried out according to the service <https://trends.google.com.ua> in 2019-2021.

Analysis of the interest over time variable courses' rate (see Figure 5) and quantitative analysis of the these courses choice, which are popular among university students (see Figure 6) shows the presence of a direct relationship between them. The selection trends indicator for the courses of "Startup development technologies" and "Business planning and project management" acquire the maximum value of 1. Moreover, the these courses choice is quite high. Thus, for these courses, the typical recommendations of group I (*Recommendation<sub>I</sub>*) are relevant. Although, it is worth noting that for the course of "Business planning and project management" there is a slight decrease in the choices number among university students.



**Figure 5:** Analysis of the interest over time variable courses' rate that are popular among students at Lviv Polytechnic National University in 2019-2021 according to the service <https://trends.google.com.ua>

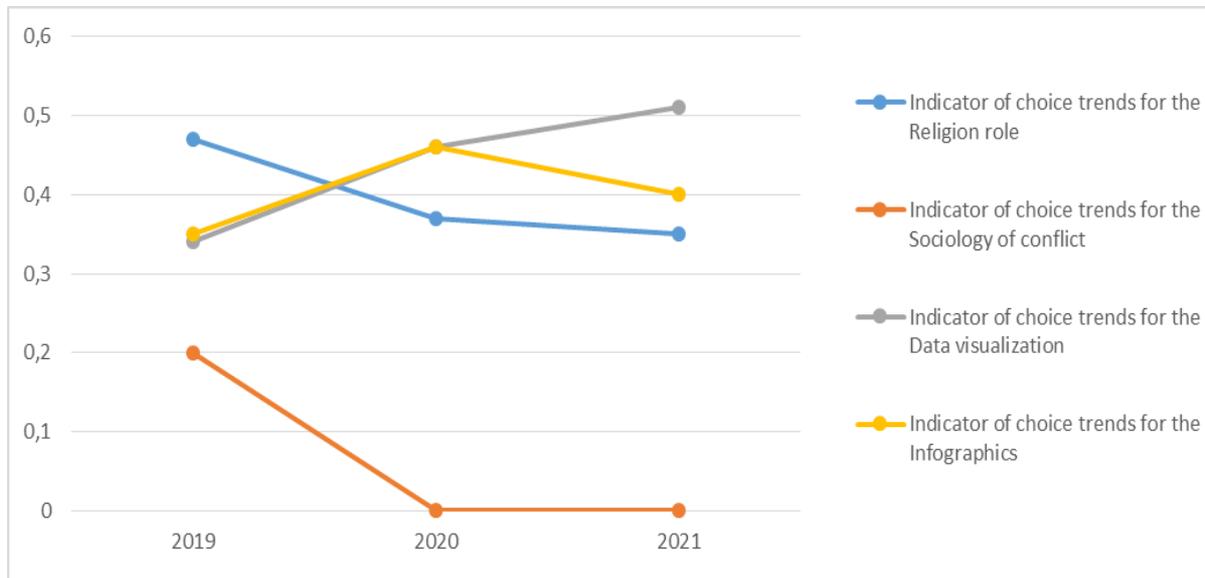


**Figure 6:** Quantitative analysis of the variable courses choice that are popular among Lviv Polytechnic National University students according to the choice of 2019-2021

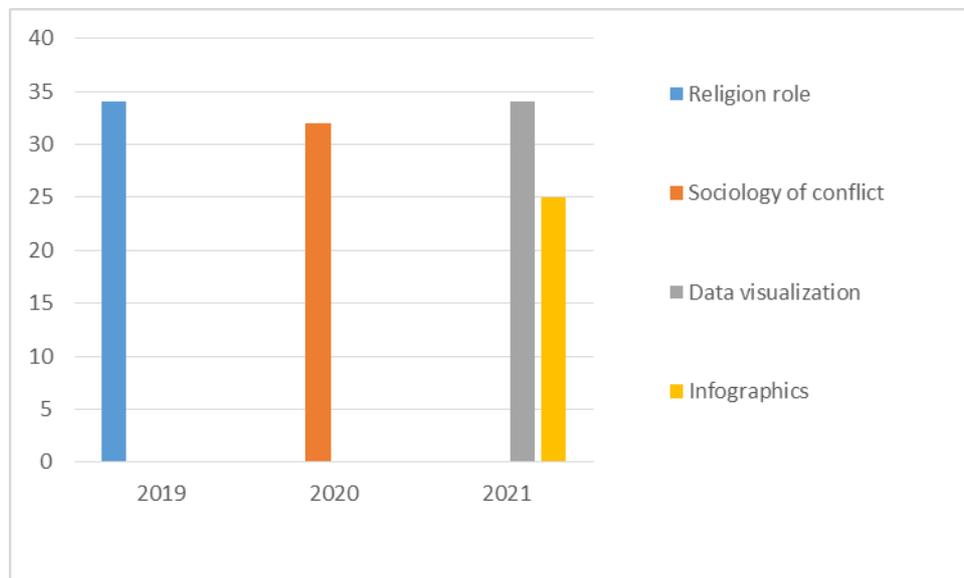
The selection trends indicator for the course of “Financial and credit support of own business” in 2020 was slightly lower than the indicators for this course in 2019 and 2021. Moreover, there is a direct relationship between this indicator and the corresponding choices of this course in these years. Since the indicator of the tendency to choose this course belongs to the interval  $[0.5, 0.7]$ , for this course the standard recommendations of the II group (*Recomendation<sub>II</sub>*) are relevant, which provide for a partial course update. This can be as a clarification of this course title, or taking into account new trends in the professional field for certain specialties students.

Selection trends indicator for the course of “Business analysis” in 2019-2021. It is characterized by an increase in the indicator value. Moreover, the quantitative course choice in 2019-2021 is also growing. The trends indicator of this course in 2019-2020 belonged to the interval  $[0, 0.5)$  and standard recommendations of type III (*Recomendation<sub>III</sub>*) were relevant for it. In 2021, this indicator belongs to the interval  $[0.5, 0.7]$ , which refers to it as a standard recommendations set of group II.

Analysis of the interest over time variable courses' rate (see Figure 7) and quantitative analysis of the courses choice, which are not popular among university students (see Figure 8) also shows a direct relationship between them.



**Figure 7:** Analysis of the interest over time variable courses' rate of that are not popular among students at Lviv Polytechnic National University in 2019-2021 according to the service <https://trends.google.com.ua>



**Figure 8:** Quantitative analysis of the variable courses choice that are not popular among Lviv Polytechnic National University students according to the choice of 2019-2021

These courses are characterized by low quantitative indicators among the choice of students. Their total popularity index, taking into account search queries, generally does not exceed 0.5. That is why the typical recommendations based on the results of the 2021 election are the recommendations of Group III (*Recomendation<sub>III</sub>*), namely a complete revision of the title and course content, taking into account the popular search queries trends among users of the World Wide Web. Only the popularity index for the course of “Data visualization” exceeds the value of 0.5, and therefore the typical

recommendations for this course are the recommendations of group II, which provides a partial update or name of the course, or refinement of knowledge, skills and abilities of the study material.

## 6. Conclusions

Therefore, this paper proposes a procedure for forming a recommendation for updating a variable course, which consists of an algorithm for determining the trend of choosing a variable course in accordance with popular search queries on the Internet and an algorithm for forming recommendations for updating variable courses. The formation of standard recommendations for a particular variable course depends on the value of the relevant choice trends indicator. The paper proposes three groups of recommendations according to the value of the selection trends indicator. Namely, the recommendations of group I (*Recomendation<sub>I</sub>*) ( $\omega_l^{(VC)} \in (0.7, 1]$ ), which establish that the variable course meets the established requirements and takes into account modern Internet trends in professional development. (*Recomendation<sub>II</sub>*) ( $\omega_l^{(VC)} \in (0.5, 0.7)$ ) provide a partial update of the course (or clarification of the name in accordance with Internet trends, or update the content of the corresponding variation course (*Recomendation<sub>III</sub>*) ( $\omega_l^{(VC)} \in [0, 0.5]$ ) provide a complete update of the variable course taking into account popular trends in the World Wide Web.

In particular, the interest indicators over time analysis and quantitative analysis of the variable courses choice according to the choice of 2019-2021 at Lviv Polytechnic National University shows a direct relationship between these indicators.

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