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QUALIMETRIC METHOD OF THE RESPONSES QUALITY ANALYSIS «THE VALUE OF OPINION» AS THE FUNDAMENTAL OF MODERN RECOMMENDATION SYSTEMS

Paper considers the urgency of the subject of the qualimetric method of the responses analysis. As in 2021 along with the growth of e-commerce sphere, where greater part of purchases occurs after the analysis of the customer's reviews, where recommendation systems are often used. Main types of psychological profiles of the customersin Internet are analyzed.

Basic types of the recommendation systems are analyzed, the drawbacks of each system are considered. Aim of the research is formulated, it is the improvement of the quality and systematization of its parameters of the reviews analysis for the development of the recommendation systems on the base of qualimetric method and tool. Scientific substantiation on the base of qualimetric approach of the reviews analysis to the algorithm of recommendations on the base of the customer "opinion" – "The Value of Opinion" and instruction of the qualimetric method "Cyclogram of the reviews quality "The Value of Opinion" is carried out.

Scientific task is formulated, it includes: systematization of reviews quality indices, based on qualimetric method; development of new indices of reviews quality on the base of the qualimetric method; possibility of introducing the index "The Value of Opinion" in the new recommendation system of the collaborative filtration, which includes the assessment of the customer's "opinion".

The expediency of using qualimetric method for the value of opinion assessment is characterized. The importance of the analysis of the cars reviews is described. Parameters of the qualimetry and problems, solved by means of these parameters in quality cyclogramare considered.

The given research considers new qualimetric approach to measuring the quality of reviews as the part of data, on which the algorithms of modern recommendation systems will be based. The system of the reviews quality assessment in the format "Cyclogram of the reviews quality "The Value of Opinion"" has the set of eight quality indices of the product review. The importance of the study for business-problems is described. Conclusions and final judgements are formulated.

Key words: *review, recommendation system, collaborative filtration, quality, qualimetry, metric.*

Introduction

Recommendation system it is a subclass of the information filtration system which, as a rule, tends to forecast "rating" or "preferences" which the customer would give to the product. They are mainly used in the commercial programs. Quality of the recommendation systems can be determined, having evaluated the quality of the algorithms operation, quality of recommendations [1].

In modern companies, mainly Internet-shops , great attention is paid to the section of customers reviews about the items. Proceeding from the assumption that the reviews it is the expression of the confidence to the brand and item, then the use of such type of the content is powerful marketing tool in the sphere of data analysis, which can be used not only for the improvement of the conversion but as a source of valuable data for the recommendation systems.

Relevance of the subject. Taking into account the fact that the recommendation system is a program, which on the base of the data about the user and item gives recommendations, such system comprises the whole process from obtaining the information to its provision to the user. Each stage is important, algorithms to be used depend on the collected information. Efficient algorithms provide qualitative, useful recommendations. Criteria of the result assessment allow to select the most accurate algorithms. Recommendation systems are used mainly by e-commerce companies [2].

Almost all IT-companies in the sphere of "e-commerce" use recommendation systems, the first company that realized such algorithms – Amazon. The largest marketplaces in Ukraine, using recommendation systems are: Rozetka, Prom, Allo, BiglandEpicentr. Also, in all large Internet-

shops are item interviews. The largest number of interviews has Rozetka – marketplace №1 in Ukraine (Fig. 1). However, as it is known from the Internet, these companies do not use the recommendation systems, taking into account items reviews. They use the reviews as the element of confidence and impact on the decision-making of the buyer of the analytical psychological type.

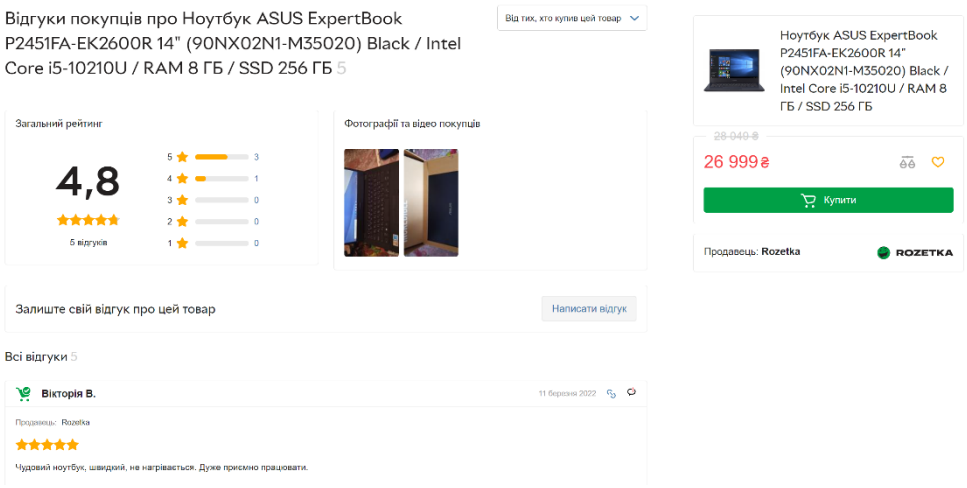

Fig. 1. Example of the reviews about the item at Rozetka.ua – marketplace with the largest amount of reviews

Number of reviews in the network constantly grows as it is seen from the data of the International statistical surveys. For instance Fig. 2 presents the amount of the reviews, created by the users on Goodreads (resource with the books reviews) from February 2012 until July 2019 [3].

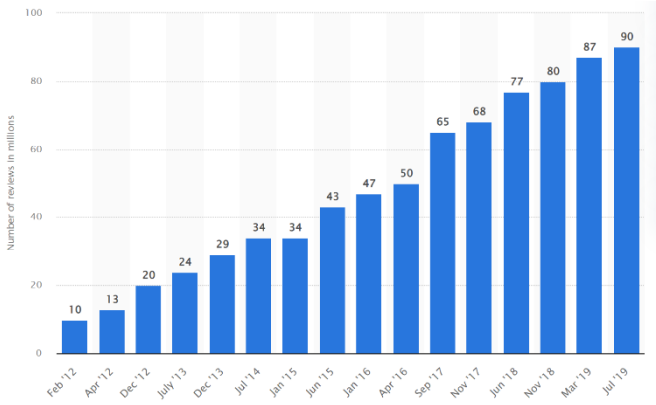

Fig. 2. Amount of the reviews, created by the users on Goodreads 2012 – 2019 (mils)

Proceeding from the analytical data of the company Statista it can be seen how many reviews read the users, analyzing the products and items in the Internet [4]. It is seen that the reviews are important first of all for the youth market (Fig. 3).

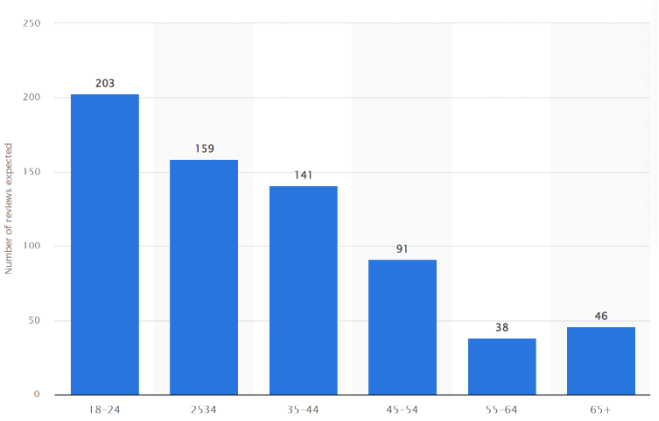

Fig. 3. Statistics regarding the amount of the browsed reviews prior to purchasing in the Internet, depending on age

According to Statista 40.5% buyers make purchases on Amazon in the United States as on January 2020, because the reviews about the items and recommendations are there (Fig. 4) [5].

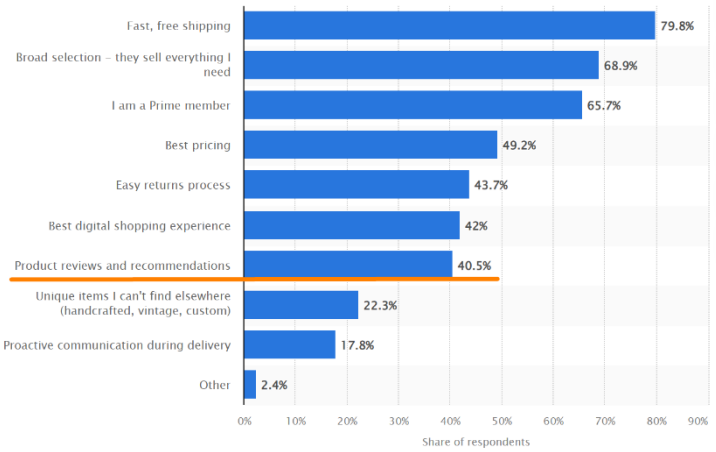

Fig. 4. Amount of Amazon buyers, who make purchases because of the availability of the reviews and recommendations

Subject of the research is relevant because on the 11th of April 2021, searching system Google updated the core of the searching algorithm under the title «Google product reviews update 2021» [6]. This algorithm basically changes the principles of sites ranking, as first of all, it takes into consideration the reviews about products and then characteristics. Thus, information from the buyer now is not less important than from the seller (description of the item). Products reviews in the search correspond to certain criteria, namely:

- Useful detail information such as advantages or disadvantages of certain items, characteristic features of the product operation or differences of the product from the previous versions.
- Reviews must be from real people, who really used the products and show the product physically or how it can be used.
- Reviews must contain unique information, besides the information, suggested by the manufacturer, for instance, visual images, audio or references to other content, where the experience of the reviewer is described in details.
- Reviews must contain the comparison of the products or explanation in what way this product differs from the competitors.

Information about the reviews is also displayed in the process of sites ranking in Google. The example is taken from the object of investigation Automoto.ua (Fig.5), however, for the

representation of the reviews special fragments of the program code in the format JSON must be on the site – data labeling, on its base search engines distinguish the types of the content, in this case - Reviews.

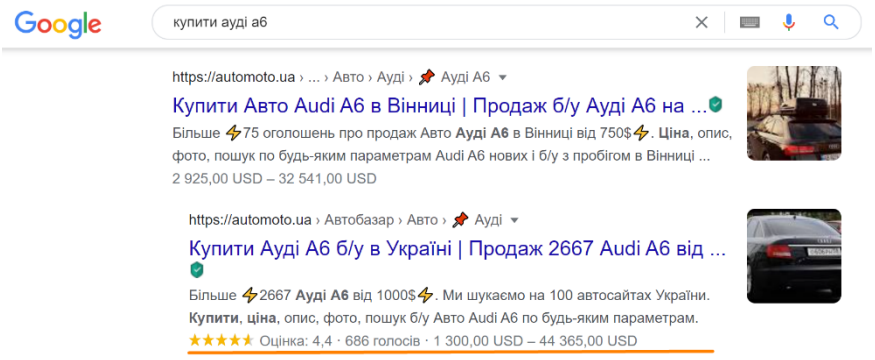

Fig. 5. Submission of the information, regarding the users` reviews of the motor vehicles

Aim and scientific tasks. Aim of the research is systematization of the reviews quality parameters on the base of qualimetric methods and tools for obtaining the indices to improve the quality of the recommendation systems.

For the realization of the highlighted aim the following tasks are to be performed:

- carry out the analysis of the recommendation systems, using the reviews and scientific publications, regarding the setup aim;
- formulate the principles of the reviews quality determination, which can be used for the improvement of the recommendations;
- study basic approaches to structuring of the characteristics of the reviews quality assessment;
- suggest qualimetric method of the reviews quality assessment for the evaluation of the user "opinion" - "Cyclogram of the reviews quality "The Value of Opinion"".

Qualimetry (English qualimetry, German -Qualimetric) (Latin - Quales+ Greek - Μετρέω) — is the science of the assessment of the objects quality, studies and realises methods and tools of decision making. Reviews quality is determined as a result of the qualimetric methods of measurements [7].

Object of the research is site-aggregator of the motor vehicles search in Automoto.ua. This searching engine specializes in the search of the advertisements for the sale of automobiles, motocycles, special vehicles and other transport facilities in Ukraine. Automoto.ua enables to perform search of the offers for sale of the motor vehicles all over Ukraine, providing the complete and actual results. Nowadays the site processes the information from more than 100 autosites of Ukraine. Every day more than 250 000 advertisements are placed in the database, 9 – 16 thousands of which are "fresh" arrivals for the current day.

*Subject of research*is qualimetric method of reviews analysis.

Results of the research

On the base of the previous studies of the algorithm of the recommendation system the user to user method of the collaborative filtration was used [8]. But this method has two basic problems:

1. Exclusiveness of the data: If the amount of the elements the user interacted with is large, their amount decreases to small percent, this makes the correlation factor less reliable.

2. Users quickly change (they find the needed motor vehicle and stop searching), the total model of the system must be recalculated, but this is time-consuming and expensive [9].

For the solution of these problems, the collaborative filtration item-to-item was used, as a result the increment of click-through-rate (CTR) is 22% on average. But the problem of the system is that it analyzes only the behavior of the "potential buyers" and does not take into account the data from "real owners"(non-sellers) [10]. That is why, it is suggested to create the third new algorithm of the collaborative filtration, which takes into account the "opinion" of the users about the automobile. It means to collect the reviews of the motor vehicle from the tens of automobile sites of Ukraine and the world -wide, and convert the text of the review in the numeral value «The Value of Opinion». Algorithm suggests the following improvements: creation of the largest in the world catalog of the reviews about the motor vehicles (up to 3 mil. reviews); analysis of the whole review and not only blocks "pluses" and "minuses"; set of 8 qualimetric matrices which comprehensively evaluate the quality of the review and form complex «The Value of Opinion»; introduction of the index «The Value of Opinion» in the basic formula of ranking the recommendation systems with the largest amount of advertisements in Ukraine.

On the base of our research and experience, having analyzed scientific works, published in Ukraine and abroad, it was established that the algorithms of recommendations, which include the analysis of the reviews, contain some drawbacks:

- Race for the accuracy improvement , measured by 1-2 indices and not in a complex manner;
- There is no correlation of the impact of the research on real business;
- There is no correlationbetween the impact of the research and informing the clients searching the items;
- Lack of the comprehensive assessment of the quality on the base of qualimetric research;
- Lack of systematization and principles of reviews quality determination, which can be used for the improvement of recommendations.

That is why, within the frame of qualimetric methods of measurement the "Cyclogram of reviews quality" is introduced (Fig. 6), where the comprehensive index "The Value of Opinion" is suggested [9].

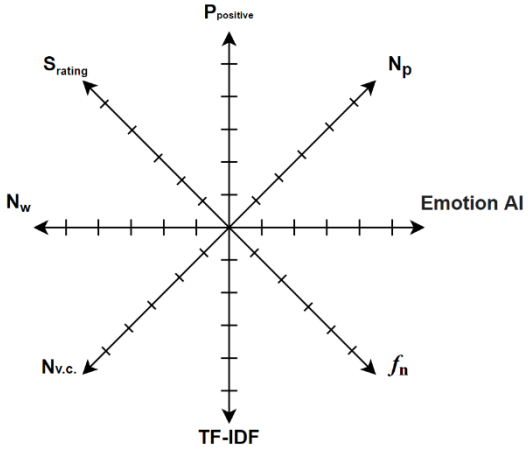

Fig. 6. Cyclogramof the review «The Value of Opinion» quality for the construction of the recommendation systems

Each metric, characterizing the quality of the reviews will be considered in details:

N_w – is number of words in the written review from the owner. The greater is the number of words, the more qualitative is the review from the point of view of the description and item characteristic.

S_{rating} – is an average assessment of the product by the user, put during the review writing, usually the assessment is from 1 to 5.

$P_{positive}$ – is the percentage of the positive thoughts (words, statements, word-combinations)

about the motor vehicle. Index is needed for basic understanding if the motor vehicle owner liked the information.

$$\boldsymbol{P_{positive}} = \frac{\boldsymbol{N_{positivethoughts}}}{\boldsymbol{N_{positive\ thoughts}+N_{negativethoughts}}}; \qquad (1)$$

For measuring $\boldsymbol{P_{positive}}$ it is necessary to create the semantic core from equally divided positive and negative words, which will be read during the analysis of each review. The example is presented in the Table 1.

Table 1

	Positive thought	***Negative thought***
1.	Fuel consumption **low**	Fuel consumption **high**
2.	Engine for 100 thousand km **not require repair**	Engine for 100 thousand km **requires repair**
3.	Gear box functions **well**	Gear box functions **bad**
N	…..	…..
50.	Nozzles were replaced **2 times**	Nozzles **were not replaced**

$\boldsymbol{N_p}$– is the total number of reviews about the chosen brand/model/year of the motor vehicle, which could be found for the recommendations.This index is needed for understanding the impact of the amount of reviews on the general ranking formula. In case of small number of the reviews about the specific models of the motor vehicles the impact on the recommendations will be less, as the representativity of the data will decreases.

Emotion AI– is the index, connected with the revealing of emotions by means of the Artificial Intelligence (AI), also it is known as affective computations. Computation is referred to the analysis of the text tonality on the base of the algorithms of machine learning and is a class of the methods of the content-analysis in the computer linguistics, designed for the automated detection in the texts the emotionally colored vocabulary and emotional evaluation of the objects by the authors.

Main aim of the tonality analysis is to find thoughts in the text and determine their properties. Properties to be studied depend on the task, put forward. The aim of the analysis is motor vehicle, the review of which is written by the owner, the "thought" belongs to. Thoughts are divided into two types: direct thought and comparison.

Direct thought contains the statement of the author about one object – motor vehicle. Formal definition of the direct thought looks like a set of five elements (*e, f, op, h, t*), where:

- (***e**ntity*, ***f**eature*) – is the object of **e** tonality (substance, regarding which the author makes a statement) or its **f** feature(attributes, parts of the object);
- ***o**rientation* or ***p**olarity* – is tonal assessment (emotional position of the author regarding the mentioned subject);
- ***h**older* – is the subject of the tonality (author, i.e. somebody, the thought belongs to);
- moment of ***t**ime*, when this though was expressed.

Examples of the tonal assessment:

- positive;
- negative;
- neutral.

"Neutral" means that the text does not contain emotional coloring. There may exist other tonal assessments.

By means of the algorithms of machine learning SVM (*support vector machine*) and LDA (*Latent Dirichlet allocation*) we determine if the review really refers to the motor vehicle (Fig. 7) and further we determine to what extent the opinion is negative or positive according to the scale from 0 to 1.

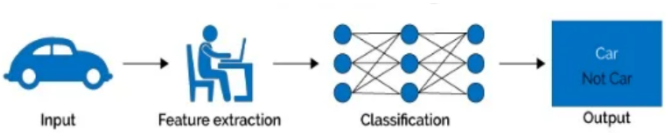

Fig. 7. Determination of the review features about the car by means of machine learning

f_n– is the index of Zipf law (rank-frequency). It is empirical regularly of the distribution frequency of the natural language words: if all the words of the language (or rather large text) are arranged by the decrease of their usage frequency, then the frequency of the *n*-th word in such list will be approximately inversely proportional to its order number *n*, i. e., to the rank of this word (Fig. 8).

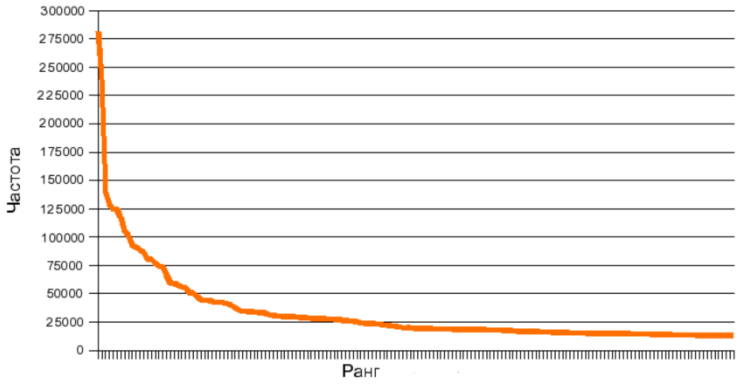

Fig. 8. Graph for the words frequency from the papers with the ranks from 3 to 170 according to Zipf law

For instance, the second by usage word occurs approximately two times less than the first word, third word – three times less than the first word and so on and so forth. Formally: *N* – is a number of elements; *k* – is their rank; *s* – is the value of the index, which characterizes the distribution.

Zipf law provides that from the set of*N* elements the normalized frequency of the element of rank*k*, *f*(*k;s,N*), is:

$$f(k;s,N)=\frac{1/k^2}{\sum_{n=1}^{N}(1/n^2)}; \quad (2)$$

TF-IDF (Eng.*TF – term frequency*, *IDF – inverse document frequency*) – is statistic index, used to assess the importance of the words in the context of the document. Weight (importance) of the word is proportional to the number of uses of the word in a document and inversely proportional to the frequency of the word use in other documents of the collection.

Index TF-IDF is used in the problems of text analysis and information search. It can be applied as one of the criteria of the documents relevance to searching relevance to the searching request and also for the calculation of the degree of documents affinity in the process of the clusterization.

Each review of the motor vehicle has a set of*N* key words, which describe the motor vehicle. Measurement of the importance index of the key words in the context of the review is proportional to the measurement of the written review quality.

TF *(term frequency)* – is the ratio of the number of the selected word input $t.t_i$to total amount of the words in the review. Thus the importance of word is evaluated within he frame of the selected review.

$$TF=\frac{n_i}{\sum_k n_k}; \quad (3)$$

where n_i is a number of inputs in the document and in the determinator – total number of words in the document.

IDF (*inverse document frequency*) – is the inversion of the frequency, the word occurs with in the catalog of the reviews. Usage of IDF decreases the weight of widely used words.

$$IDF = \frac{|D|}{|(d_i \supset t_i)|}; \quad (4)$$

where

- $|D|$– is the number of the reviews of the catalog;
- $|(d_i \supset t_i)|$– is the number of reviews, where the word t t_i (when $n_i \neq 0$) occurs).

Selection of the logarithm base in the formula makes no difference, as the change of the base will lead to the change of the weight of each word by constant multiplier, i. e. weight ratio remains unchanged.

In other words, index TF-IDF is the product of two multipliers: TF and IDF.

$$TF - IDF = TF \cdot IDF; \quad (5)$$

Greater weight of TF-IDF obtain words with high frequency of occurrence within the review and low frequency of usage in other reviews of the catalog.

$N_{v.c.}$ – (*number of visual content*) is a binary value on the level of the review and quantitative value on the level of the catalog of reviews, responsible for the availability of visual content (photo, video) which gives the additional value and quality to the review for the user and is factor of impact of Google in the process of reviews analysis.

Conclusions

It is determined that there is no unified system of the assessment of the reviews quality that could be used for the improvement of the recommendation systems. Availability of the reviews on the site is mainly used as a marketing and trust tool, as it is proved by the analysis of the open data about the companies and recommendation systems, they use .

Principles of reviews quality determination, namely, the set of matrices, which are qualimetric base of quality: N_w, S_{rating}, $P_{positive}$, N_p, *Emotion AI,* f_n, *TF-ID,* $N_{v.c.}$ *are formulated.* These 8 matrices form “Cyclogram of reviews quality “The Value of Opinion””. Besides the suggested qualimetric approach to measurement, cyclogram comprises new index – «*Emotion AI*», based on the algorithms of machine learning SVM and LDA for the analysis of the text tonality and will enable to analyze the emotions of the motor vehicle owner and determine his “thought”, expressed in the format of the numerical index.

The suggested “Cyclogram of reviews quality “The Value of Opinion”” can be used for the analysis of any reviews about items in the Internet in order to improve the quality of recommendation systems and user’s experience while purchasing on the whole, and is universal for usage.

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Recommended by the Chair of Metrology and Industrial Automation.

Editorial office received the paper 18.09.2021.
The paper was reviewed26.09.2021.

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