UDC 655.5+004.8

AN APPROACH TO ASSESSING THE QUALITY OF DIGITAL PUBLICATIONS USING COMPUTATIONAL INTELLIGENCE

S. V. Kovalenko[1], T. Ye. Aleksandrova[2], S. M. Kovalenko[3], N. A. Marchenko[4]

1. National Technical University «Kharkiv Polytechnic Institute», 2 Kyrpychova St., Kharkiv, 61002, Ukraine https://orcid.org/0000-0001-8763-0862 e-mail: serhii.kovalenko@khpi.edu.ua
2. National Technical University «Kharkiv Polytechnic Institute», 2 Kyrpychova St., Kharkiv, 61002, Ukraine https://orcid.org/0000-0001-9596-0669 e-mail: tetiana.aleksandrova@khpi.edu.ua
3. National Technical University «Kharkiv Polytechnic Institute», 2 Kyrpychova St., Kharkiv, 61002, Ukraine https://orcid.org/0000-0001-6770-6778 e-mail: svitlana.kovalenko@khpi.edu.ua
4. National Technical University «Kharkiv Polytechnic Institute», 2 Kyrpychova St., Kharkiv, 61002, Ukraine https://orcid.org/0000-0001-9889-3713 e-mail: natalia.marchenko@khpi.edu.ua

An approach to the comprehensive assessment of the quality of digital publications based on the use of fuzzy logic methods is proposed. The quality of a digital publication is considered as an integral characteristic that reflects compliance with informational, structural, visual, technical, ergonomic, and multimedia requirements. A mathematical model for quality assessment is developed, which includes the normalization of partial indicators, their interpretation as fuzzy variables, the construction of a fuzzy rule base, and the implementation of fuzzification, aggregation, accumulation, and defuzzification procedures using the Mamdani inference algorithm. The developed approach can serve as a foundation for intelligent systems for auto-mated analysis, comparative evaluation, and improvement recommendations for digital publications. Further research is aimed at integrating machine learning and computer vision methods to automatically adjust the parameters of the fuzzy model and enhance the objectivity of quality assessment.

Keywords: *digital publications, quality assessment, fuzzy logic, fuzzy inference sys-em, Mamdani algorithm, integral quality indicator, linguistic variables, membership functions, intelligent evaluation systems.*

Problem statement. The assessment of the quality of a digital publication is neces-sary to increase the informative value, ease of use and competitiveness of digital publica-tions, as well as to develop and implement intelligent systems for automated analysis of multimedia content [1]. The process of evaluating a publication is a necessary stage of its design, implementation and further operation, since it provides an objective determination of the level of compliance of the publication with functional, informational and user re-quirements. In modern conditions of rapid growth in the volume of digital content, the issue of quality becomes particularly relevant, because a high-quality digital publication in itself determines the effectiveness of communication between the author and the user [2].

First, quality assessment allows you to identify shortcomings in the structure, content, and visual design of a digital publication. Analysis of the logical organization of the material, readability, design consistency, and technical stability allows you to timely correct errors, increase the convenience of navigation, and improve the user's perception of information.

Secondly, quality assessment is a tool for ensuring that a digital publication meets established standards and requirements. This applies to both educational and scientific resources and commercial multimedia products, for which the correct presentation of information, accessibility on different devices, and compliance with digital publishing requirements are important.

Third, systematic quality assessment creates a basis for comparative analysis of digital publications. Integral quality indicators allow for ranking, reasonably choosing the most effective solutions, and making management decisions regarding the modernization or replacement of digital products.

Fourth, quality assessment is important for automating content control and recommendation processes. Combined with artificial intelligence methods, it makes it possible to build intelligent systems that automatically analyze digital publications, predict their level of user perception, and generate recommendations for improving their structure and design.

Finally, from a scientific point of view, the assessment of the quality of digital publications is the basis for studying the effectiveness of computer vision and fuzzy logic methods. It allows you to formalize subjective quality criteria, reduce the influence of the human factor and increase the reproducibility of research results. The use of fuzzy logic methods is appropriate, since many quality indicators are subjective, linguistic or vaguely formalized in nature.

Analysis of recent research and publications. The assessment of the quality of printed products is well developed in publications [3-5]. But digital publications have significant differences from printed products, therefore [1, 2, 6] provides criteria for assessing the quality of this type of publication. Fuzzy logic is widely used to assess the quality of objects and processes of various natures [7-12]. The application of fuzzy logic methods to assess the quality of digital publications is considered in [13, 14]. At the same time, insufficient attention is paid to the factors that should be taken into account in a comprehensive quality indicator.

Purpose of the article is focused on the formalized representation of the relationships between the factors influencing the quality of digital publications through the use of fuzzy logic mechanisms, which serves as a prerequisite for the synthesis of an integral quality assessment model that determines the priority influence of content, structural, visual, technical, ergonomic, and multimedia factors on the overall quality of a digital publication.

Presentation of the main research material. The quality of a digital publication is an integral characteristic that reflects the degree of compliance of a digital publication with informational, functional, technical and user requirements, taking into account the conditions of its perception, use and distribution in the digital environment.

From a scientific and applied point of view, the quality of a digital publication is determined by its ability to effectively transmit information, provide convenient interaction with the user, and function stably on various software and hardware platforms.

An integral assessment of the quality of a digital publication includes the following key aspects (fig. 1):

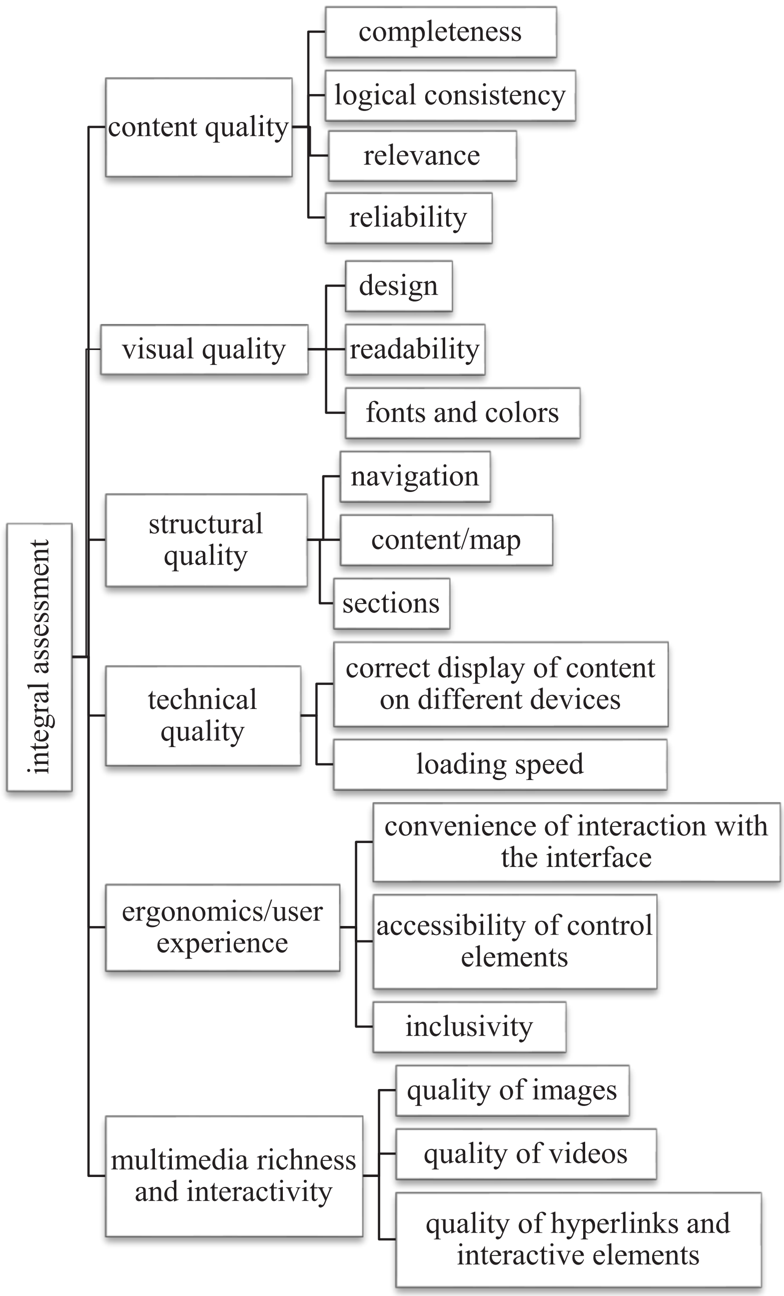

Fig. 1. Components of an integrated quality assessment

1) content quality, which characterizes the completeness, reliability, relevance and logical consistency of the information content. High content quality ensures that the material corresponds to the target audience and the purpose of the publication;

2) structural quality, reflecting the organization of the material, the presence of a clear hierarchy of sections, convenient navigation, and logical connection between content elements;

3) visual quality, which is determined by readability, harmony of design, correct use of colors, fonts and graphic elements. It directly affects the perception of information and the comfort of using the publication;

4) technical quality, which includes stability of operation, loading speed, correct display of content on different devices and in different browsers, as well as compliance with digital publishing formats and standards;

5) ergonomics and user experience, which characterize the convenience of interaction with the interface, the accessibility of control elements, and the adaptability of the publication to user needs.

6) the level of multimedia and interactivity, which determines the appropriateness and quality of using images, videos, animations, hyperlinks and interactive elements.

It is advisable to assess the quality of a digital publication using fuzzy logic, since the category of "quality" itself is complex, multidimensional, and predominantly subjective in nature and cannot be adequately described only by rigid, deterministic rules, since most indicators of the quality of a digital publication do not have clear boundaries. Characteristics such as "convenient navigation", "high readability", "harmonious design" or "sufficient level of multimedia" cannot be unambiguously attributed to the states of "good" or "bad". Fuzzy logic allows us to describe these properties in the form of linguistic variables ("low", "medium", "high quality") and take into account smooth transitions between them. On the other hand, indicators of the quality of a digital publication are often heterogeneous (non-uniform): some of them have a quantitative form (loading speed, number of multimedia elements), and some of them are qualitative (aesthetics of design, ease of navigation).

In addition, the assessment of the quality of digital publications is largely based on expert judgments, which are fuzzy in nature. Fuzzy logic allows us to formalize expert knowledge in the form of IF-THEN rules, while maintaining the interpretability of the model and the transparency of the decision-making process.

The fuzzy inference system consists of the following stages (Fig. 2):

1. Formation of a database of fuzzy logical rules that reflect expert knowledge about the properties of the object under study. A fuzzy rule is a formalized description of cause-and-effect relationships and has the form:

$$R: \text{"IF } x \in A, \text{THEN } y \in B\text{"}, \tag{1}$$

where the statement $x \in A$ is a prerequisite of the rule and describes the membership of the input variable in a certain fuzzy set, and $y \in B$ – the conclusion of the rule that determines the fuzzy characteristic of the output variable.

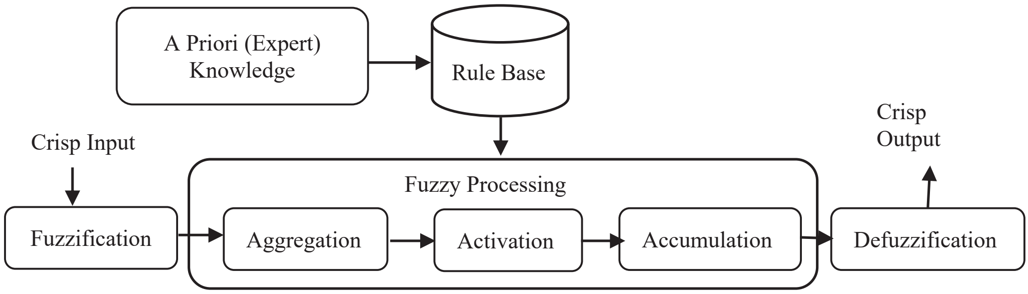

Fig. 2. Block diagram of the fuzzy logic inference system

2. Fuzzification of input variables, i.e., the transformation of clear values of input variables into their fuzzy representation. At this stage, a correspondence is established between a specific numerical value of the input variable and the degrees of its membership in the terms of the corresponding linguistic variable by using membership functions.

3. Aggregation of subconditions in fuzzy rules – if the premise of a fuzzy rule contains several subconditions, they are combined using fuzzy logic logical operations (for example, conjunction operations). As a result, the overall degree of truth of the condition of each rule is determined. Only active rules for which the degree of truth of the premise is greater than zero are taken into account for further processing.

4. Activation of sub-conclusions of fuzzy rules – the degree of truth of the conclusions of active fuzzy rules is determined. This is achieved by applying activation methods, in particular, minimum cutoff or scalar multiplication, which allow to match the degree of truth of the conclusion with the degree of activation of the rule's precondition.

5. Accumulation of fuzzy rule outputs, which consists in combining fuzzy sets corresponding to the outputs of all active rules into a single resulting fuzzy set for each output variable. Typically, this is done using the maximum operation, which allows taking into account the contribution of each rule to the formation of the final result.

6. Defuzzification of the output variables, which involves transforming the resulting fuzzy set into a clear numerical value of the output variable. The most common defuzzification methods are the center of gravity (center of area) method, which provides an integral estimate taking into account the entire form of the aggregated fuzzy set.

So, let's formalize the task of evaluating a digital publication as follows:

Let the digital publication be considered as a complex information object consisting of a set of pages, visual and structural elements. Let us define it as a set

$$E = \{P_1, P_2, ..., P_N\}, \tag{2}$$

where P_k – k -the page or screen representation of the publication, N – total number of pages.

A vector of partial quality indicators is formed for each page

$$x_k = (x_{k1}, x_{k2}, ..., x_{km}), \tag{3}$$

where x_{ki} — value i-th quality indicator (content, structural, visual, technical, ergonomic, etc.), obtained on the basis of automated analysis or expert assessment. All indicators are pre-normalized: $x_{ki} \in [0,1], i = 1,...,m$.

The aggregate vector of quality indicators of a digital publication is defined as the aggregated score across all pages:

$$x = \frac{1}{N}\sum_{k=1}^{N} x_k . \tag{4}$$

Each indicator x_i interpreted as a fuzzy variable

$$\tilde{x}_i = \left(X_i, T_i, \mu_{ij}\right), \tag{5}$$

where $X_i = [0,100]$ – universe i-th quality indicator, $T_i = \{t_{i1}, t_{i2}, ..., t_{ip}\}$ – a set of linguistic terms, $\mu_{ij} : X_i \to [0,100]$ – membership functions.

The overall quality of a digital publication is described by a fuzzy variable

$$\tilde{Q} = \left(Q, T_Q, \mu_Q\right), \tag{6}$$

where $Q = [0,100]$ – the universe of integrated quality assessment, $T_Q = \{\text{low, medium, high}\}$ – linguistic levels of general quality, μ_Q – corresponding membership functions.

According to fuzzy set theory, the relationship between partial indicators and the integral quality assessment is given by a fuzzy rule base of the form

$$R_k : \text{IF}\, x_1 \in t_{1j_1} \wedge x_2 \in t_{2j_2} \wedge ... \wedge x_n \in t_{nj_n} , \tag{7}$$

where $k = 1,...,K$ – rule number.

Fuzzy inference is performed using the Mamdani algorithm [12]. The activation degree of the kth rule is defined as

$$\alpha_k = \min_{i=1,...,n} \mu_{ij_i}\left(x_i\right), \tag{8}$$

and the resulting membership function for the output variable is formed according to the aggregation rule

$$\mu_Q^*\left(q\right) = \max_{k=1,...,K} \min\left(\alpha_k, \mu_{Q_k}\left(q\right)\right), \tag{9}$$

To obtain a clear numerical value of the integral quality of a digital publication, defuzzification is performed, for example, using the center of gravity method:

$$Q^* = \frac{\int q\mu_Q^*\left(q\right)dq}{\int \mu_Q^*\left(q\right)dq} . \tag{10}$$

The Harrington desirability scale (table 1) [15] can be applied to the obtained value for better interpretation of the evaluation results.

Table 1

Correspondence of standard values on the desirability scale to quality scores

Value of the desirability function	Quality assessment
1.00–0.80	Very good
0.80–0.63	Fine
0.63–0.37	Satisfactory
0.37–0.20	Poor
0.20–0.00	Very bad

Membership functions will be defined in the classes of triangular and trapezoidal functions, since they are the most common in expert assessment tasks. These functions have a simple mathematical form, are easily interpreted and allow us to clearly specify the areas of confidence and uncertainty between quality levels. For the quality criteria of digital publications, which do not have sharp boundaries between the states "low", "medium" and "high", such functions are most adequate.

Trapezoidal functions were used for extreme linguistic terms ("low" and "high" quality), since they reflect a situation where a certain interval of values is unambiguously interpreted by experts as a clearly low or clearly high level of quality. For example, very slow loading or, conversely, stable and fast operation of the publication almost does not raise doubts in the classification, so the degree of membership in these intervals is equal to one.

Triangular functions were applied to the term "medium quality" because it is transitional and the most uncertain. The maximum of the function corresponds to the typical or "representative" value of the indicator, while the edges of the triangle reflect a gradual decrease in confidence in belonging to the medium level.

The overlap of the membership functions was set deliberately. It reflects the real situation when the same indicator value can simultaneously partially belong, for example, to "medium" and "high" quality. It is this overlap that ensures the smoothness of the fuzzy inference and prevents sharp jumps in the integral estimate.

The parameters of the membership functions were selected taking into account the normalized rating scale and typical expert opinions. The centers of the triangular functions correspond to the medium values of the indicators, and the boundaries of the trapezoids correspond to the threshold values at which the quality is unambiguously perceived as low or high.

We will announce the following quality indicators: x_1 – content quality; x_2 – visual quality; x_3 – structural quality; x_4 – technical quality; x_5 – ergonomics; x_6 – multimedia.

For each quality indicator, the values range from 0 to 100, i.e. we will use a pre-normalized scale: $x_i \in [0, 100], i = 1, ..., n$.

For each quality indicator, we will introduce linguistic terms: $T = \{\text{low, medium, high}\}$.

We will create the membership function of the term "low quality" in the class of trapezoidal membership functions:

$$\mu_{low}(x)=\begin{cases}1, & 0\le x\le 20,\\ \dfrac{80-x}{60}, & 20<x<80,\\ 0, & x\ge 80.\end{cases} \quad (11)$$

We will create the membership function of the term "medium quality" in the class of triangular functions

$$\mu_{medium}(x)=\begin{cases}0, & 0\le x\le 20\\ \dfrac{x-20}{30}, & 20<x\le 50,\\ \dfrac{80-x}{30}, & 50<x<80,\\ 0, & x\ge 80.\end{cases} \quad (12)$$

We will create the membership function of the term "high quality" as for the term "low quality" in the class of trapezoidal membership functions:

$$\mu_{high}(x)=\begin{cases}0, & 0\le x\le 20,\\ \dfrac{x-20}{60}, & 20<x<80,\\ 1, & x\ge 80.\end{cases} \quad (13)$$

We will use the same membership functions for all quality components. For example, consider the form of membership functions for the linguistic variable "visual quality" (Fig. 3.)

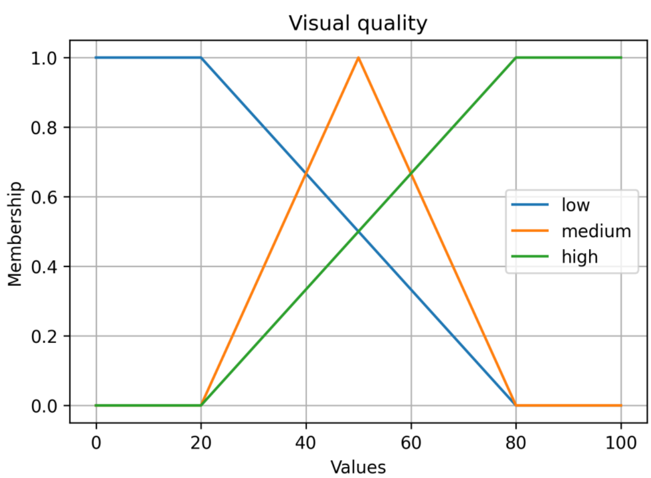

Fig. 3. Membership functions of the terms "low", "high", "medium" of the indicator "visual quality"

For the term “low quality”, the membership function has the form:

$$\mu_{low}(x)=\begin{cases}\dfrac{30-x}{30}, & 0<x<30,\\ 0, & x\geq 30.\end{cases} \tag{14}$$

We will create the membership function of the term “medium quality” in the class of triangular functions.

$$\mu_{medium}(x)=\begin{cases}0, & 0\leq x\leq 20\\ \dfrac{x-20}{30}, & 20<x\leq 50,\\ \dfrac{80-x}{30}, & 50<x<80,\\ 0, & x\geq 80.\end{cases} \tag{15}$$

The term “high quality” has the following membership function:

$$\mu_{high}(x)=\begin{cases}0, & 0\leq x\leq 70,\\ \dfrac{x-70}{30}, & 70<x<100.\end{cases} \tag{16}$$

The appearance of the membership functions of the terms of the variable “integral quality” is given in Fig. 4.

The next step is to create a fuzzy rule base. The fuzzy rule base is formed taking into account the priority of the quality criteria of the digital publication (table 2). Critical values of content, technical, structural, visual quality, ergonomics and multimedia lead to a decrease in the integral assessment regardless of other indicators, which corresponds to the expert logic of evaluating digital publications.

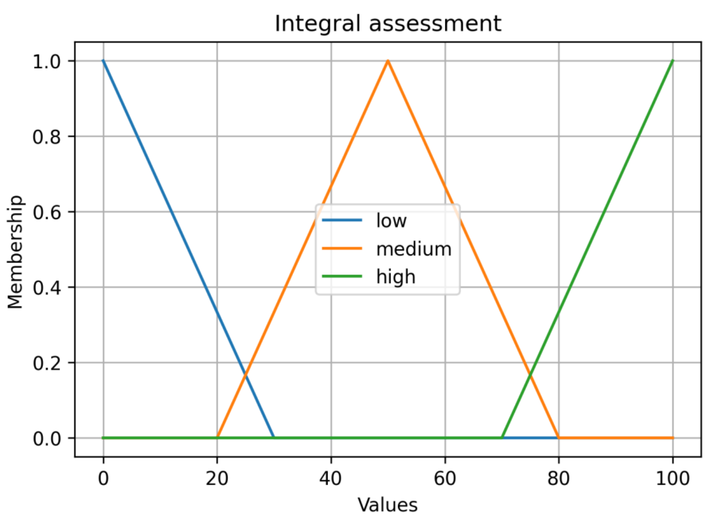

Fig. 4. Membership functions of the terms “low”, “high”, “medium” of the indicator “integral quality”

Let us consider only the "critical" rules, because in systems it is not necessary to have a rule for each possible combination, because each rule is activated partially, and the result is formed as an aggregation of all activated rules.

Formal rule R_1 can be written as

$$\begin{gathered}\text{IF } x_1 \in \text{high} \wedge x_2 \in \text{high} \wedge x_3 \in \text{high} \wedge x_4 \in \text{high} \wedge \\ x_5 \in \text{high} \wedge x_6 \in \text{high, THEN } Q \in \text{high,}\end{gathered} \tag{17}$$

where $\wedge$ – a fuzzy conjunction implemented using t-norms and used to combine multiple fuzzy conditions in fuzzy inference rules.

Table 2

Fuzzy rules

No.	x_1	x_2	x_3	x_4	x_5	x_6	Q
R_1	high	any	any	any	any	any	any
R_2	any	high	any	any	any	any	any
R_3	any	any	high	any	any	any	any
R_4	any	any	any	high	any	any	any
R_5	any	any	any	any	high	any	any
R_6	any	any	any	any	any	high	any
R_7	any	any	any	any	any	any	high
R_8	low	any	any	any	any	any	any
R_9	any	low	any	any	any	any	any
R_{10}	any	any	low	any	any	any	any
R_{11}	any	any	any	low	any	any	any
R_{12}	any	any	any	any	low	any	any
R_{13}	any	any	any	any	any	low	any
R_{14}	any	any	any	any	any	any	low

The most common t-norm is the minimum operator, which interprets the truth of a conjunction as the minimum degree of membership among all conditions:

$$A \wedge B = \min\left(\mu_A, \mu_B\right). \tag{18}$$

Thus, the degree of activation of the rule is calculated as a minimum among the membership functions

$$\alpha_k = \min\left(\mu_{x_1}^{t_1}, \mu_{x_2}^{t_2}, \mu_{x_3}^{t_3}, \mu_{x_4}^{t_4}, \mu_{x_5}^{t_5}, \mu_{x_6}^{t_6}\right). \tag{19}$$

and aggregation of rules as

$$\mu_Q^*(q) = \max_k \min\left(\alpha_k, \mu_{Q_k}(q)\right). \tag{20}$$

The final stage of fuzzy logic inference is defuzzification – aggregated fuzzy set transformation process $\tilde{Q}$ into a clear scalar value Q^*.

The proposed evaluation system uses the center of gravity method (centroid method) (10), because it: takes into account the entire form of the aggregated set provides smooth and stable estimation is the most common in quality problems.

For our case, we will use the approximate formula for calculating the centroid

$$Q^* \approx \frac{\sum q_i \cdot \mu_Q(q_i)}{\sum \mu_Q(q_i)} \quad (21)$$

Experiment. Suppose that when evaluating a digital publication, experts assessed individual components of the integral assessment as shown in table 3.

Table 3

The meaning of the components of an integrated quality assessment

Definition	Variable	Value
Content quality	x_1	92
Visual quality	x_2	80
Structural quality	x_3	75
Technical quality	x_4	90
Ergonomics	x_5	71
Multimedia richness	x_6	70

The application of the above methodology was implemented using the Python programming language with the skfuzzy, numpy, and matplotlib libraries.

For the input variables given in Table 3, the integral score value Q=72.16 was obtained (Fig. 5). Using the Harrington desirability scale (Table 1) to obtain a verbal score, it can be concluded that the evaluated digital publication has fine overall quality.

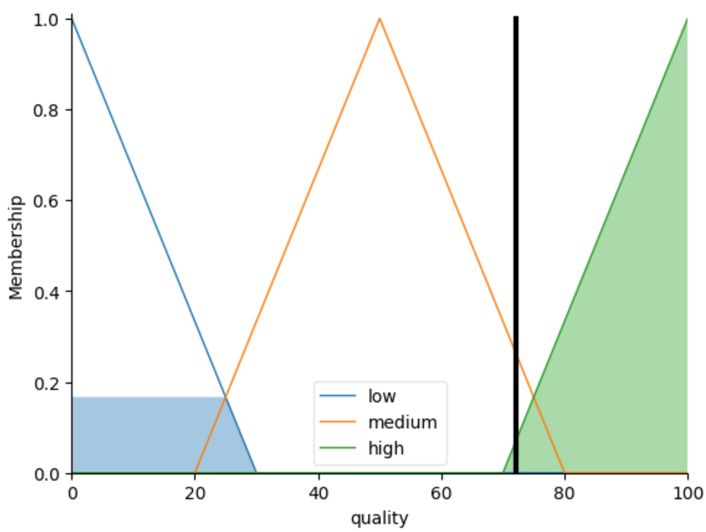

Fig. 5. Aggregated fuzzy set of the output variable and the result of defuzzification

Conclusions: The task of comprehensive assessment of the quality of digital publications is considered as a problem that combines quantitative and qualitative characteristics. It is shown that traditional deterministic approaches do not provide adequate consideration of subjective factors inherent in such concepts as usability, readability, design aesthetics, and the level of multimedia.

An approach to assessing the quality of a digital publication is proposed based on the fuzzy logic apparatus and the Mamdani algorithm, which allows for the formalization of expert knowledge in the form of linguistic variables and a base of fuzzy rules of the "IF–THEN" type. The research identifies key components of an integrated quality assessment, namely, content, structural, visual, technical quality, ergonomics, and the level of multimedia, which provides a comprehensive analysis of a digital publication.

A mathematical evaluation model has been developed, which includes the normalization of partial indicators, their interpretation as fuzzy variables, the formation of a rule base and the procedures of fuzzification, aggregation, accumulation and defuzzification. The choice of triangular and trapezoidal membership functions, which adequately reflect expert ideas about smooth transitions between quality levels and ensure the stability of fuzzy inference results, has been justified.

The formed base of fuzzy rules takes into account the priority of individual quality criteria and allows to correctly respond to critical values of individual indicators, which corresponds to the real practice of expert evaluation of digital publications. It is shown that for the effective operation of the fuzzy system it is not necessary to completely search through all possible combinations of conditions, since the result is formed as an aggregated contribution of partially activated rules.

The practical applicability of the proposed approach is confirmed by an experimental example implemented using the Python programming language using the skfuzzy, numpy, and matplotlib libraries. The obtained value of the integral quality assessment and its interpretation using the Harrington desirability scale demonstrate the clarity of the proposed method.

The proposed model of fuzzy quality assessment of digital publications can be used as a basis for building intelligent systems for automated analysis of digital content, comparative evaluation of digital publications and formation of recommendations for their improvement. Further research should be directed towards the integration of machine learning and computer vision methods for automatic adjustment of the parameters of the fuzzy model.

REFERENCES

1. Banionis, V. (2025). Digital vs Print Magazines: A Complete Guide to Modern Publishing Formats. https://flip180media.com/tips-for-periodical-publishers/digital-vs-print-magazines--a-complete-guide-to-modern-publishing-formats/

2. Hall, F. (2022). The Business of Digital Publishing: An Introduction to the Digital Book and Journal Industries (2nd ed.). Routledge. https://doi.org/10.4324/9780429423314

3. Khadzhynova, S., & Havenko, S. (2020). Devising a procedure for examining the quality of prints of digital and offset printing on corrugated cardboard. Eastern-European Journal of Enterprise Technologies, 5(1 (107), 81–89. https://doi.org/10.15587/1729-4061.2020.212075

4. Özomay, Z., Şahin, C., & Keskin, B. (2021). Investigation of the effect of different screening methods on print quality in digital printing system. Politeknik Dergisi, 24(3), 1213-1217. https://doi.org/10.2339/politeknik.884893

5. Wei, Y., Zhang, T., & Qi, Y. (2021). Research on the Quality of Digital Printing. In Advances in Graphic Communication, Printing and Packaging Technology and Materials: Proceedings of 2020 11th China Academic Conference on Printing and Packaging (pp. 284-292). https://doi.org/10.1007/978-981-16-0503-1_42

6. Caldwell, C. (2024). Editorial Design Third Edition: Digital and Print. Hachette UK.

7. Megel, Y., Kovalenko, S., & Mikhnova, O. (2019). An approach to quantitative assessment of inbound tourism impact on the country’s economy. *Information Processing Systems*, *3*(158), 65-72. https://doi.org/10.30748/soi.2019.158.07

8. Kutsenko, A., Kovalenko, S., Kovalenko, S., Kashcheiev, L., Mikhnova, O., & Chaly, I. (2020, October). A Fuzzy Logic Based Approach to E-tourist Attractiveness Assessment. In 2020 IEEE 2nd International Conference on System Analysis & Intelligent Computing (SAIC) (pp. 1-8). IEEE. https://doi.org/10.1109/SAIC51296.2020.9239184

9. Megel, Y., Mikhnova, O., Kovalenko, S., Kovalenko, S., Rybalka, A., Chalyi, I., & Blagov, I. (2020, September). Measuring Multimedia Content Proximity via Artificial Intelligence Methods. In 2020 XXX International Scientific Symposium’Metrology and Metrology Assurance (MMA) (pp. 1-5). IEEE. https://doi.org/10.1109/MMA49863.2020.9254237

10. Díaz-Curbelo, A., Espin Andrade, R. A., & Gento Municio, Á. M. (2020). The role of fuzzy logic to dealing with epistemic uncertainty in supply chain risk assessment: review standpoints. International Journal of Fuzzy Systems, 22(8), 2769-2791. https://doi.org/10.1007/s40815-020-00846-5

11. Hriday, M. S. H. (2022). Quantitative Risk Assessment of Rail Infrastructure Projects Using Monte Carlo Simulation and Fuzzy Logic. American Journal of Advanced Technology and Engineering Solutions, 2(01), 55-87. https://doi.org/10.63125/h24n6z92

12. Watkar, V. B. (2022). Fuzzy Inference Systems: Types & Applications. Journal of Emerging Technologies and Innovative Research (JETIR). Vol. 9, no. 12, 2022. – P. 347–351.

13. Huang, X., & Chen, M. (2025). Application of Fuzzy Logic Inference Engine in Digital Culture Industry. International Journal of High Speed Electronics and Systems, Vol. 35, No. 3. 2540390. https://doi.org/10.1142/S0129156425403900

14. Repeta, V., Havrylyshyn, O., & Myklushka, I. (2021, September). Modelling of the Factors Influence on the Quality of the Digitization Process of Old Books by Fuzzy Logic. In 2021 IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT) (Vol. 2, pp. 182-185). IEEE. https://doi.org/10.1109/CSIT52700.2021.9648627

15. Aulin, V., Rogovskii, I., Titova, L., Mironov, D., Volianskyi, M., Solomka, O., & Lysenko, S. (2024). Comprehensive assessment of technical condition of vehicles during operation based on Harrington’s desirability function. 1 (3 (127). – P. 37–46. https://doi.org/10.15587/1729-4061.2024.298567

doi: 10.32403/0554-4866-2026-1-91-113-127

ПІДХІД ДО ОЦІНЮВАННЯ ЯКОСТІ ЕЛЕКТРОННИХ ВИДАНЬ З ВИКОРИСТАННЯМ ОБЧИСЛЮВАЛЬНОГО ІНТЕЛЕКТУ

С. В. Коваленко[1], Т. Є. Александрова[2], С. М. Коваленко[3], Н. А. Марченко[4]

1. Національний технічний університет «Харківський політехнічний інститут», вул. Кирпичова, 2, Харків, 61002, Україна https://orcid.org/0000-0001-8763-0862
e-mail: serhii.kovalenko@khpi.edu.ua
2.Національний технічний університет «Харківський політехнічний інститут», вул. Кирпичова, 2, Харків, 61002, Україна https://orcid.org/0000-0001-9596-0669
e-mail: tetiana.aleksandrova@khpi.edu.ua
3.Національний технічний університет «Харківський політехнічний інститут», вул. Кирпичова, 2, Харків, 61002, Україна https://orcid.org/0000-0001-6770-6778
e-mail: svitlana.kovalenko@khpi.edu.ua
4.Національний технічний університет «Харківський політехнічний інститут», вул. Кирпичова, 2, Харків, 61002, Україна https://orcid.org/0000-0001-9889-3713
e-mail: natalia.marchenko@khpi.edu.ua

Запропоновано підхід до комплексного оцінювання якості електронних (цифрових) видань на основі застосування методів нечіткої логіки. Актуальність дослідження зумовлена стрімким зростанням обсягів цифрового контенту та необхідністю використання об'єктивних, формалізованих інструментів для оцінювання якості видань із урахуванням суб'єктивних чинників, таких як зручність використання, читабельність, естетика дизайну та рівень мультимедійної інтеграції. Показано, що традиційні детерміновані методи оцінювання є недостатніми для адекватного опису зазначених характеристик через їх лінгвістичну та слабкоформалізовану природу. Якість електронного видання розглядається як інтегральна характеристика, що відображає відповідність інформаційним, структурним, візуальним, технічним, ергономічним та мультимедійним вимогам.

Розроблено математичну модель оцінювання якості, яка передбачає нормалізацію часткових показників, їх інтерпретацію як нечітких змінних, побудову бази нечітких правил, а також реалізацію процедур фазифікації, агрегації, акумуляції та дефазифікації з використанням алгоритму нечіткого виведення Мамдані. Обґрунтовано доцільність використання трикутних і трапецієподібних функцій належності для відображення плавних переходів між рівнями якості. Запропонована база нечітких правил враховує пріоритетність і критичність окремих критеріїв якості, забезпечуючи адекватну реакцію на низькі значення ключових показників незалежно від інших параметрів.

Практичну застосовність підходу продемонстровано на експериментальному прикладі, реалізованому мовою програмування Python із використанням бібліотек skfuzzy, numpy та matplotlib. Отримане значення інтегральної оцінки якості *інтерпретовано за шкалою бажаності Гаррінгтона, що підтверджує наочність та інтерпретованість результатів оцінювання.*

Розроблений підхід може бути використаний як основа для побудови інтелектуальних систем автоматизованого аналізу, порівняльного оцінювання та формування рекомендацій щодо вдосконалення електронних видань. Подальші дослідження будуть спрямувати на інтеграцію методів машинного навчання та комп'ютерного зору для автоматичного налаштування параметрів нечіткої моделі та підвищення об'єктивності оцінювання якості.

Ключові слова*: електронні видання, оцінювання якості, нечітка логіка, система нечіткого виведення, алгоритм Мамдані, інтегральний показник якості, лінгвістичні змінні, функції приналежності, мультимедійний контент, інтелектуальні системи.*

This is an Open Access article distributed under the terms of the Creative Commons CC-BY 4.0
© С. В. Коваленко, Т. Є. Александрова,
С. М. Коваленко, Н. А. Марченко

Стаття надійшла до редакції 20.03.2026
Received 20.03.2026
Стаття прийнята 22.05.2026
Accepted 22.05.2026
Опубліковано 30.05.2026
Published 30.05.2026