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Olena Volvach
PhD Student, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine;
e-mail: lena.volvach@gmail.com
ORCID: 0000-0001-5491-6960

INNOVATIVE TOOLKIT FOR FORMING AN EPS PORTFOLIO FOR ELECTRONIC TRADING PLATFORMS

ABSTRACT

When companies enter the e-commerce market, choosing an electronic payment system that fits well with the way they do business is relevant and one of the main concerns. Realizing this, almost all stakeholders are studying the different types of electronic payment systems and the challenges associated with electronic payment systems and digital currency. This study is aimed at outlining innovative tools for forming a portfolio of electronic payment systems for modern trading platforms in the e-commerce market. Achieving this goal involves solving a number of tasks, in particular highlighting the features of the application of electronic payment systems and the criteria that form the basis of the formation of an effective electronic payment systems (EPS) portfolio. Within the framework of this study, multi-criteria optimization using fuzzy logic methods was applied as a decision-making method to help trading platforms make decisions regarding the evaluation of EPS efficiency and the formation and management of a portfolio of electronic payment systems among a wide range of possible options. The research results demonstrate the high effectiveness of fuzzy logic methods, in particular Fuzzy TOPSIS, to achieve the research goal. The conclusions and recommendations formed will be useful both from a theoretical and a practical point of view for representatives of e-commerce and the scientific society in order to develop the methodology for managing electronic payment systems.

Keywords: electronic commerce, portfolio strategy, electronic trading platform, electronic payment system, innovations; unclear logic, mathematical model, fuzzy TOPSIS

JEL Classification: G14, G31, O31, C10, C13, C52

INTRODUCTION

The era of information and communication technology (ICT) and digital innovation is leading to dynamic changes in the business environment, where business transactions continue to shift from cash to electronic transactions. In recent years, with the development of Internet technologies, the popularity and importance of electronic payment systems have grown, especially for electronic commerce and modern trading platforms. Online payment can provide a convenient, safe, fast receipt of required goods or services (Jiang et al., 2013; Ponte et al., 2015). The system of electronic payments was introduced not to replace cash but as a better alternative to cash and trade barter. Electronic payments can be understood as a payment mechanism using electronic media that does not include cash. The electronic payment system is an important aspect of electronic commerce (Fatonah et al., 2018).

Due to its widely recognized benefits, many companies are adopting electronic payment systems for commercial transactions, so electronic payment system (EPS) is being investigated with increasing interest (Oney et al., 2017). Currently, financial electronic payments can be mainly divided into online banking (Martins et al., 2014), mobile payments (Slade et al., 2015) and third-party online payments - third-party EPS (Huang et al., 2014; Roy & Venkateswaran, 2014).

When companies enter the e-commerce market, choosing an e-payment system that fits well with the way they do business is relevant and one of the main challenges (Yu

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et al., 2002; Khalili et al., 2012). In today's online shopping environment, the decision-making problem faced by the user is complex and changing (Lei et al., 2017; Oat, 2016). When making decisions, it is most appropriate to take into account various evaluation criteria in order to make the most appropriate choice (King et al., 2014). Thus, multi-criteria decision-making becomes an important method often used by decision-makers (Zhang, 2016; Chen et al., 2017).

Within the framework of this study, multi-criteria optimization will be applied as a decision-making method to help trading platforms make decisions regarding the formation and management of a portfolio of electronic payment systems among a wide range of possible options.

LITERATURE REVIEW

The emergence of electronic commerce has created new financial needs, which in many cases cannot be effectively met by traditional payment systems. Realizing this, almost all stakeholders are studying the different types of electronic payment systems and the challenges associated with electronic payment systems and digital currency. Electronic payment systems can be divided into four categories: online credit card payment systems, online electronic cash systems, electronic check systems and smart card-based electronic payment systems. Each payment system has its advantages and disadvantages for customers and merchants (Sumanjeet, 2009).

The book by O'Mahony et al. (2001) provides comprehensive information on how electronic payments are made using credit cards, electronic cash, bill transfers and micropayments. The author outlines information on how payments are made and provides a detailed overview of the cryptographic techniques required for online payments.

There are a number of requirements for electronic payment systems such as security, acceptability, convenience, cost, anonymity, control and traceability, so instead of focusing on the technological characteristics of different electronic payment systems, Sumanjeet (2009) distinguished electronic payment systems based on what is transmitted over the network, and analyzed the differences of each electronic payment system, evaluating their requirements, characteristics and applicability of the system itself.

Wright (2002) evaluates 3 types of payment systems: credit cards, an electronic check system, and 2 digital cash systems, in terms of privacy, traceability, transaction cost, and ability to model customer purchases. The author also assesses their advantages and disadvantages for the customer, merchant, electronic payment service provider and financial institution. These systems use cryptography for security, but many consumers are still reluctant to buy online because they are concerned that hackers will gain access to their financial information. However, the author proposes a new system that is designed to eliminate this problem by allowing payments for purchases made over the Internet to be made using the telephone network.

When payments are made over a telecommunications network such as the Internet, accuracy and security become critical. Other factors influencing the choice of alternative systems, such as their application environment, their potential for evolution, and their likely acceptance by vendors and consumers, should also be considered. In the article by Yu et al. (2002) examines the advantages and limitations of several different electronic payment systems: online credit card payments, electronic cash, electronic checks, and retail payments. Systematic and detailed comparisons of alternative systems are presented. This analysis is intended for use by companies that plan to implement or improve the system of electronic payments.

The influence of trust and security on the use of EPS has long been recognized in the e-commerce literature. Research by Oney et al. (2017) developed a conceptual model to examine the determinants of perceived safety and trust, and the impact of perceived safety and trust on EPS use using structural equation modeling (SEM). The results show that perceived safety and trust have a significant effect on the use of EPS (Figure 1). Technical protection and past experience were found to be common determinants of security and trust.

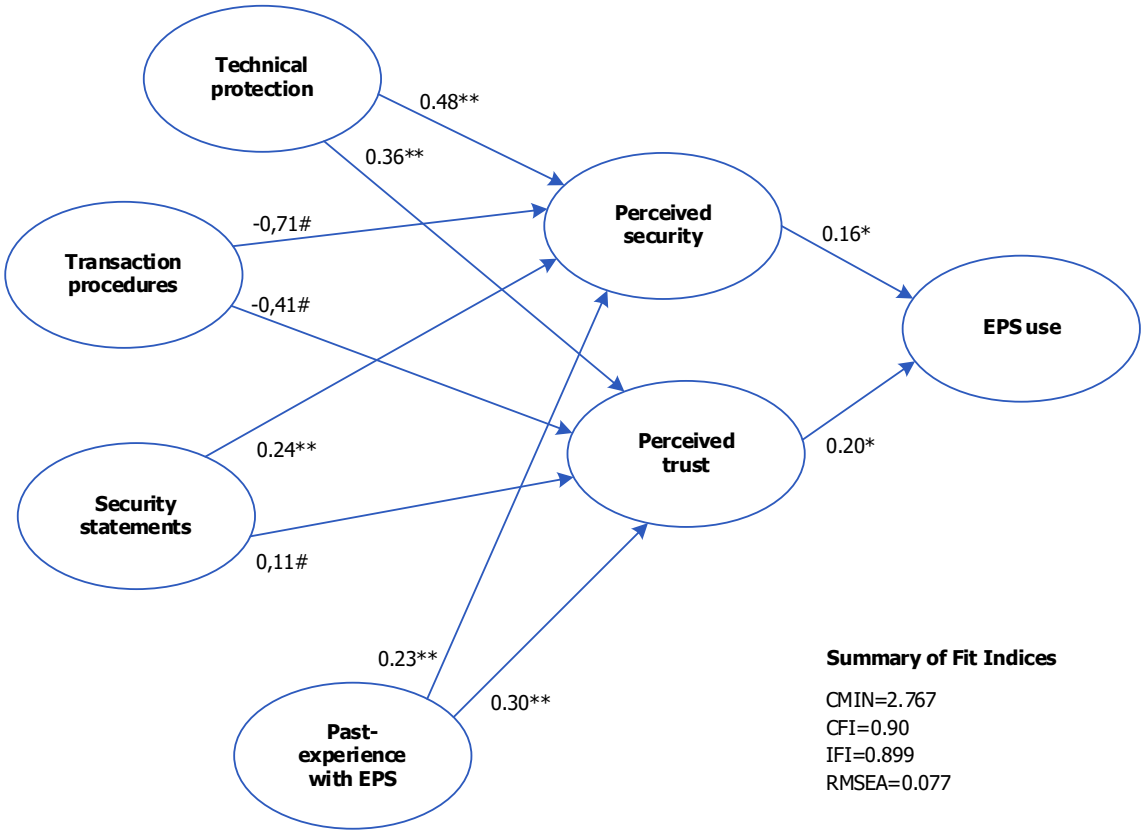

Figure 1. The results of setting up the proposed model in the study of Oney et al. (2017). Notes: *significant at p<0,05; ** significant at p<0,01; # - not a significant contribution. *(Source: Oney et al., 2017).*

The purpose of the study by Hamidiniva et al. (2010) is an assessment of the characteristics of electronic payment systems from the perspective of Iranian bank users. The revision of the specifications was carried out in four substructures, such as technical, legal, security and socio-economic. It is necessary to take this topic into account for the design and installation of appropriate electronic payment systems. In the process of research, statistical data were analyzed using SPSS software and one-way analysis of variance and the Kruskal Wallis test. According to research, the main factor in the evaluation of electronic payment services, according to users, is the socio-economic index.

Consumers shopping online can choose between several payment methods (e. g. credit card, PayPal, invoice). These payment methods differ among themselves in the time of receipt of cash and the awareness of consumers about it. Deufel et al. (2018) investigate the influence of demographics and consumer habits (in the form of repeatedly used payment methods) on the choice of payment method through a discrete choice model. The authors came to the conclusion that especially frequent customers choose to postpone payment - if possible. Customer characteristics are secondary to habitual behaviour when it comes to predicting payment method choice. The results of a field experiment (A/B test) show that regular customers react especially sensitively and interrupt the ordering process when the deferred payment option is removed from the seller's website.

Considering the impact of online payments on the development of e-commerce, the article by Xu et al. seeks to deepen the current understanding of the determinants of online payment method choice. Based on an extensive literature review, the authors identified perceived seller trustworthiness and perceived product uncertainty as the main determinants and suggested that product type, product price, and product description are antecedents of product uncertainty. In the theoretical framework, the authors modelled perceived seller trustworthiness and perceived product uncertainty as independent variables that are hypothesized to determine the dependent variable, namely the choice of online payment method (credit card, debit card, or cash on delivery). In addition, they identify payment method characteristics (eg, information security) and buyer characteristics (eg, propensity to trust, online shopping experience) as control variables. In addition, a laboratory experiment was described in which the theoretical basis was tested. Given the growing popularity of neurobiological research, the authors suggest using eye-tracking data to complement traditional data sources, especially those obtained through survey research. In particular, eye-tracking data can be used to measure product uncertainty, a major predictor

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of online payment method choice, which is associated with unconscious and automatic processing of information that cannot be easily captured by self-reports.

An expert system can be used to make a complex decision about choosing an EPS in a changing environment. Addo (1999) proposed a prototype of an expert system for the selection of EPS based on the analysis and evaluation of the main electronic payment systems. The goal of the thesis was to develop a rule-based expert system that would assist the requirements analysis process by asking relevant questions; maintaining a knowledge base about the safety characteristics of various EPS; and containing the knowledge necessary to select and implement an appropriate system that meets the organization's security requirements. An extensive literature review was conducted to evaluate the main EPS to determine the applicability, strengths, and weaknesses of each system. The features of each were analyzed with a special focus on safety aspects. The results were used to design and prototype a rule-based system to help organizations determine an appropriate security strategy in EPS.

Peterson et al. (2012) developed a performance-based tool, namely the Electronic Payments Efficiency Quotient (EPEQ), designed to assist merchants in selecting appropriate EPS and measuring performance. The study aims to address the need for EPS research to help retailers select and use EPS. The article presents a case study of one Internet service provider to determine the seller's EPS needs and develop appropriate measures. Historical data was used to identify and validate the most effective alternative measures. The paper concludes with recommendations to help optimize the use of EPS by merchants.

Despite the significant achievements of domestic and foreign scientists, the issue of forming a portfolio of electronic payment systems for representatives of e-commerce remains relevant, especially regarding the use of innovative approaches, information technologies and mathematical research methods.

AIMS AND OBJECTIVES

This study is aimed at outlining innovative tools for forming a portfolio of electronic payment systems for modern trading platforms in the e-commerce market. Achieving this goal involves solving a number of tasks, in particular highlighting the features of the application of electronic payment systems and the criteria that form the basis of the formation of an effective EPS portfolio, as well as the formation of an approach to the use of multi-criteria analysis methods in order to solve the task of prioritizing EPS.

METHODS

Research involves the use of both general scientific methods (analysis and synthesis, logic, etc.) and special research methods. Thus, within the framework of this study, multi-criteria optimization was applied as a decision-making method to help trading platforms make decisions regarding the formation and management of a portfolio of electronic payment systems among a wide range of possible options. The methodology of using Fuzzy TOPSIS as an approach to fuzzy multi-criteria analysis was formed.

RESULTS

As e-commerce becomes increasingly critical to an organization's survival in the 21st-century global marketplace, business organizations are faced with the challenge of choosing the best alternative payment options to meet both their requirements and the needs of their customers (Peterson et al., 2012).

With the rapid growth of e-commerce, organizations are often faced with the challenge of choosing an appropriate e-payment system to suit their requirements. Although demand is growing rapidly, the main reason holding back the growth of e-commerce is security concerns. Organizations that choose individual EPSs with different protection methods find it extremely difficult to do business with each other. Choosing an EPS is a difficult task. Firms often lack the necessary internal expertise to make such choices. Hiring external consultants with expertise in this field can be expensive. The wrong decision can have a significant negative impact. Implementation of EPS requires considerable technical expertise. Difficulties related to selection and implementation include identifying the firm's requirements, understanding the available EPS options, and evaluating the best option based on economic, technical, and operational challenges (Addo, 1999).

Let's consider the criteria that determine the effectiveness of the electronic payment system (Figure 2).

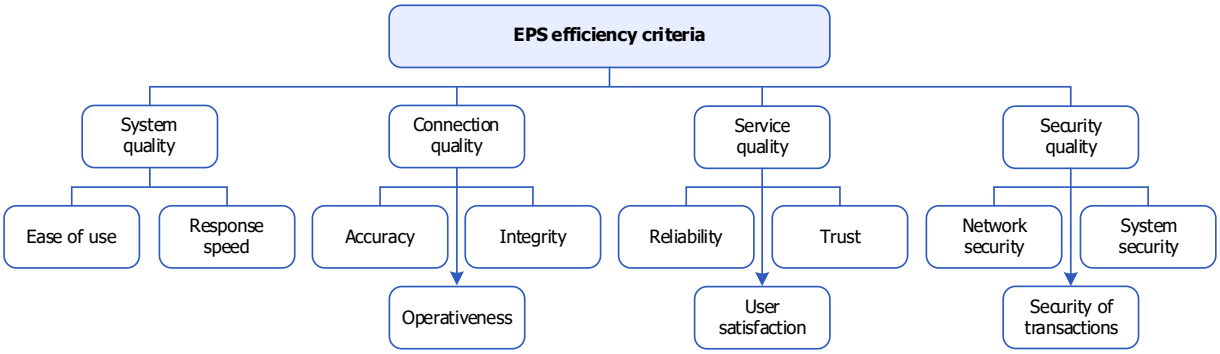

Figure. 2. EPS efficiency criteria. *(Source: compiled by the author based on information from Chen et al., 2017)*

System quality measures the ease of use and responsiveness. The measure of the quality of the connection includes the correctness of the information. The quality of service is an indicator of the trust of service consumers, user satisfaction, and reliability of services. Security quality is system security, transaction security, and network security.

System quality is defined as accessibility and increased user-friendliness to improve system support. Connection quality is defined as the ability to provide quick feedback to users using system information. Quality of service determines how easily the user can operate the system. In addition, the quality of financial electronic payments by key factors such as system quality, connection quality, service quality and security quality will affect the consumer and their satisfaction (Fang et al., 2014). Thus, these criteria will be key factors that will affect the quality of financial electronic payments and the efficiency of EPS (Chen et al., 2017).

Depending on the specific EPS, the impact of each of these criteria on the final result will differ, which creates the potential to optimize and increase the efficiency of EPS portfolio management for a trading platform in the e-commerce market.

Let's consider the Fuzzy TOPSIS methodology for prioritizing EPS for e-commerce, which involves expert assessments of the impact of various criteria and the formation of an EPS rating based on their priority for inclusion in the portfolio of modern trading platforms (Figure 3).

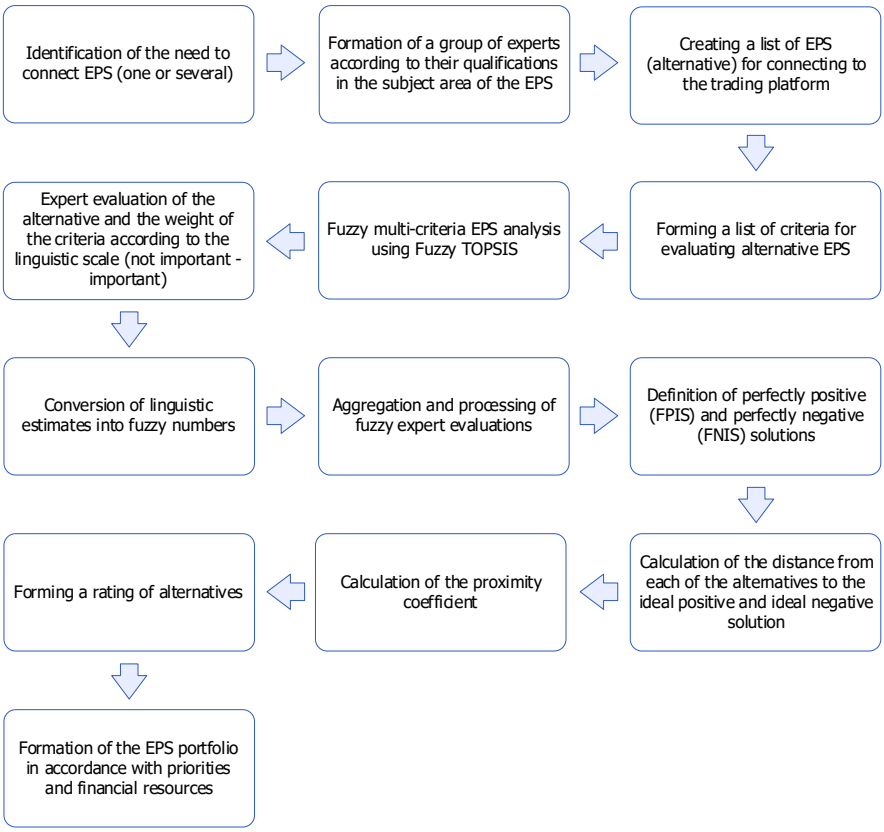

Figure 3. A methodical approach to the formation of the EPS portfolio based on fuzzy multi-criteria analysis Fuzzy TOPSIS.

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The main stage of applying the methodology begins with the evaluation of alternatives on a linguistic scale by a group of experts (E_1, E_2, …, E_l). It is assumed that there are m possible alternatives (A_1, A_2, … , A_m), which must be evaluated according to *n* criteria (C_1, C_2, … , C_n). Thus, the weight of the criteria will be denoted as W_{jk} (j=1,2, … , n; k=1,2, … , l), and the evaluation of alternatives as X_{ijk}=(i=1,2, … , m; k=1,2, … , l; j=1,2, … , n).

Fuzzy sets are setting whose elements have degrees of belonging, so linguistic terms can be translated into fuzzy triangular numbers (Table 1), which can be represented as *(a, b, c)*. Their membership functions can be described by the formula:

$$\mathrm{F}(x) = \begin{cases} \frac{x-a}{b-a}, a \le x \le b \\ \frac{c-x}{c-b}, b \le x \le c \\ 0 \end{cases} \quad (1)$$

Table 1. Belonging of linguistic terms to fuzzy triangular numbers. *(Source: compiled by the author)*

Linguistic terms	Triangular number
Very high	(4;5;6)
High	(3;4;5)
Middle	(2;3;4)
Low	(1;2;3)
Very low	(0;1;2)

The next step is the aggregation of fuzzy evaluations of alternatives and criteria weights. Given that W_{jk} and X_{ijk} are represented by fuzzy triangular numbers (a_k, b_k, c_k) (k=1,2, …, l), the aggregated estimate is defined as follows:

$$\mathrm{a} = \min\{a_k\}, b = average(b_k), c = \max\{c_k\} \quad (2)$$

Based on the calculated aggregated fuzzy scores, the criteria are ranked according to their importance for decision-making.

The next step is to normalize the data. If the criterion has a monotonically decreasing function, then the normalized value will be determined by the formula: $\left(\frac{a_k}{c}, \frac{b_k}{c}, \frac{c_k}{c}\right), c = \max\{c_k\}$, and if the criterion has a monotonically increasing function, then the normalized indicators will be calculated by the formula:

$$\left(\frac{a}{a_k}, \frac{a}{b_k}, \frac{a}{c_k}\right), a = \min\{a_k\}. \quad (3)$$

Next, it is necessary to weight the normalized expert fuzzy estimates by multiplying the normalized estimates of the alternatives obtained in the previous step by the weights of the criteria that were calculated earlier:

$$\widetilde{V_{ljk}} = \widetilde{W_{jk}} * \widetilde{X_{ljk}}. \quad (4)$$

The next step is to calculate the ideal positive solution (FPIS) and the ideal negative solution (FNIS):

$$FPIS = (c_V, c_V, c_V) \quad (5)$$

$$FPIS = (a_V, a_V, a_V) \quad (6)$$

Where $c_V = max\left(c_{V_{ljk}}\right); a_V = min\left(a_{V_{ljk}}\right)$

It is important to consider that some of the criteria have a monotonically decreasing objective function, and some have a monotonically increasing objective function.

In the next step, you need to estimate the distance from each alternative to the ideal positive and negative solutions, using the following calculation formulas:

$$S^+ = \sqrt{\frac{1}{3}\left[\left(a_{V_{ljk}} - c_V\right)^2 + \left(b_{V_{ljk}} - c_V\right)^2 + \left(c_{V_{ljk}} - c_V\right)^2\right]} \quad (7)$$

$$S^- = \sqrt{\frac{1}{3}\left[\left(a_{V_{ljk}} - a_V\right)^2 + \left(b_{V_{ljk}} - a_V\right)^2 + \left(c_{V_{ljk}} - a_V\right)^2\right]}$$

The last step is the calculation of the proximity coefficient $R_i = \frac{\sum_1^n s_{ij}^-}{\sum_1^n s_{ij}^+ + \sum_1^n s_{ij}^-}, i = 1, 2, \ldots, m,\ j = 1,2,\ldots,n.$ Alternatives are ranked according to the proximity coefficient, and the higher the value of this indicator, the more attractive the alternative is.

In order to make sure of the correctness of the decision made, it is also worth conducting a sensitivity analysis by changing the weight of the criteria. For this, it is necessary to consistently change the weights of one criterion while maintaining the same values for other criteria. Based on the results of the sensitivity analysis, it can be concluded that the rating of alternatives for different scenarios varies, but if in most cases the best solution coincides and the rating is quite close, then this indicates the high reliability of the obtained results. It is important to note that when forming an EPS portfolio, it is advisable not only to choose your best solution but also to consider other alternatives to complement and strengthen the effectiveness of the formed portfolio. In this case, those of them that are next in terms of positions in the formed rating are taken into account.

Next, we will consider the results of the implementation of the outlined Fuzzy TOPSIS approach, based on the results of the survey of 15 experts on electronic payments in accordance with the criteria of EPS efficiency presented in Figure 2.

In the beginning, the weight of the basic and detailed levels of the criteria is calculated, and the order of importance of the sub-criteria is evaluated using the TOPSIS methodology, on the basis of which the key factors of the efficiency of the electronic payment system (EPS) are further determined.

The greatest attention of experts is focused on:

- transaction security (10.22%), which implies the need to ensure information security in the process of activity;
- ease of use (7.77%), that is, convenience for the user of the financial electronic payments system;
- reaction speed (7.22%);
- system security (5.98%), which refers to network security privacy, e-mail security usage, network community, and communication security;
- trust (5.22%), which is based on the positive expectations of the user.

The above criteria, ease of use and response speed are the quality assessment criteria of the main criteria. System security and network security belong to the security quality assessment criteria. Trust is the quality of service.

It can be seen that the higher the relative importance of the subcriteria, the higher the importance of the main criteria. The importance of all 11 evaluation sub-criteria has a high share, so users and experts believe that security quality, system quality and information quality are the most influential on the quality of the electronic financial payment system. The key influencing factors and their importance are presented in the Table. 2.

Table 2. The general assessment of the level of importance of the main and detailed criteria and their sorting. *(Source: compiled by the author based on the data of Chen et al., 2017)*

The main criterion	Weight, %	Sub-criterion	Weight, %	Sorting
System quality	24.49	Ease of use	7.77	2
		Reaction speed	7.22	3
Quality of communication (information)	23.18	Precision	4.82	7
		Integrity	4.05	8
		Operativeness	4.19	9
Quality of service	20.07	Reliability	2.72	10
		Trust	5.28	5
		User satisfaction	2.68	11
Safety quality	32.26	Network security	5.02	6
		System security	5.98	4
		Security of transactions	10.22	1

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Given the different importance of each factor, the priority value and weight of each criterion are not the same.

According to the comprehensive value of each criterion for different types of EPS, it was found that the best solution is third-party EPS, the second is Internet banking, and mobile payments are somewhat less popular among users and experts. Table 3 shows the influence of key factors on the selection of general priorities for EPS and complex values of weights.

Table 3. Weight of factors for different types of EPS. *(Source: compiled by the author based on the data of Chen et al., 2017)*

Sub-criterion	Weight, %	Internet banking	Mobile banking	EPS of third parties
Ease of use	7.77	90	89	93
Reaction speed	7.22	90	90	89
Precision	4.82	88	87	91
Integrity	4.05	90	89	90
Operativeness	4.19	91	90	93
Reliability	2.72	93	89	93
Trust	5.28	90	88	91
User satisfaction	2.68	89	89	93
Network security	5.02	91	90	94
System security	5.98	90	89	93
Security of transactions	10.22	89	88	92
AVERAGE VALUE		54,306	53,671	55,460
PRIORITY		2	3	1

The key advantage of the Fuzzy TOPSIS method for forming the final EPS priority ranking is that it is not complicated and easy to understand in practice. TOPSIS requires two basic prerequisites: criterion weight, a monotonically increasing or monotonically decreasing property (Garg & Narahari, 2009). It is for the functioning of the system of financial electronic payments and the formation of an effective portfolio that the quality of each of the key factors is of great importance. Thus, the decision matrix after data normalization, which is obtained using the described steps of the method, is presented in the Table. 4.

Table 4. Matrix of decisions for the formation of priorities regarding EPS. *(Source: compiled by the author based on the data of Chen et al., 2017)*

EPS	Safety quality	System quality	Quality of communica-tion	Quality of service
Internet banking	0.3453	0.2441	0.2051	0.2053
Mobile banking	0.3423	0.2641	0.2083	0.2051
EPS of third parties	0.2951	0.2782	0.2086	0.2181
Weight	0.2643	0.2585	0.2441	0.2331
FPIS	0.2840	0.2653	0.2370	0.2137
FNIS	0.2315	0.2482	0.2552	0.2651

Let's go to the next step in the Fuzzy TOPSIS method to determine the ideal positive solution (FPIS) and the ideal negative solution (FNIS), the results of which for each criterion are presented in the Table. 5. Next, we calculate the distance between the option and the ideal positive and negative solution so that the scheme to be chosen is the closest to the ideal solution, and the distance from the negative ideal solution is the furthest (Table 6).

Table 5. A perfect positive and a perfect negative solution for each criterion. *(Source: compiled by the author based on the data of Chen et al., 2017)*

	EPS	Safety quality	System quality	Quality of communication	Quality of service
FPIS	Internet banking	0.1868	0.0982	0.1204	0.0652
	Mobile banking	0.1258	0.0504	0.1140	0.0452
	EPS of third parties	0.2172	0.1686	0.1340	0.0852
FNIS	Internet banking	0.0885	0.0725	0.1365	0.0728
	Mobile banking	0.0986	0.0952	0.1568	0.0852
	EPS of third parties	0.0752	0.0523	0.1227	0.0530

Next, we calculate the indicators S+ and S- as the distance to the ideal positive and ideal negative solution, as well as the measure of closeness R_i to the ideal solution for each EPS. The indicators sorted by degree of closeness are given in the Table. 6.

Table 6. The relative proximity of each type of EPS. *(Source: compiled by the author based on the data of Chen et al., 2017)*

EPS	R_i	Priority for portfolio
Internet banking	0.5721	2
Mobile banking	0.3763	3
EPS of third parties	0.7532	1

Consolidating the results of the evaluation of the importance of the criteria, the highest priority belongs to third-party EPS, followed by Internet banking and mobile payments according to the assessment of experts and users (according to the results of their survey).

DISCUSSION

The current research continues our previous research presented in Volvach (2023) and has a significant contribution to the methodology of formation of the portfolio of different electronic payment systems. The results of the research confirmed the significant influence of security factors and quality factors on the efficiency of the EPS (described previously by different scientists, for example, Hamidiniva et al. (2010)) and on the decision to involve some specific EPS in the EPS portfolio of e-commerce trading platform.

As well as, considering the large influence of social demographics and behavioural characteristics of EPS consumers (confirmed by Deufel et al. (2018)), it should be stated that the structure of the criteria and determination of the weight of their influence, the establishment of the EPS efficiency evaluation model will differ from the needs of users, which lead to nieces-variety of validation the results of methodology implementation taking into account the cultural, economic and other specifics of the market.

The proposed methodology shows important results for practitioners and will have a positive impact on the future development of EPS theory.

CONCLUSIONS

The outlined innovative mechanism for the formation of an effective EPS portfolio for representatives of e-commerce is based on the results of the implementation of the fuzzy multi-criteria optimization method Fuzzy TOPSIS. It is shown that the proposed methodology makes it possible to clearly understand the influence of a number of criteria on the quality and efficiency of the EPS, in particular the criteria of the quality of the system itself, the quality of communication (information), the quality of service (service) and the quality of security, each of which can consist of a number of sub-criteria detailing basic level criteria. Such a double evaluation model makes it possible to evaluate the impact of the criteria in more detail and in the future to ensure a gradual increase in the efficiency of the use of EPS through the formation of the priority of their involvement for modern trading platforms in the e-commerce market.

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Theoretical and practical results establish meaningful recommendations for representatives of e-commerce who plan to choose and use various systems for making electronic financial payments. Based on the results of the study, it is proven that the quality of safety should be considered as the first factor for the effectiveness of the EPS (its weight is more than 32%). Transaction security and network security occupy a key place among the sub-criteria of security quality as the main criterion. In addition, it was found that the quality of the system as a basic level criterion, which includes ease of use and speed of response, is one of the TOP factors for choosing an EPS. The results prove that the weights of the other two criteria (information quality and service quality) that outline the key aspects of service satisfaction are relatively low, but they are still necessary to evaluate the overall performance of different alternatives in the EPS market. The different weight of each criterion and their different combination in different types of EPS is a reflection of the user's behaviour during electronic payments, as the consumer will, first of all, pay attention to the security aspects, and then consider the ease of payment operations and ease of use.

The limitations of the current study should be considered considering only part of the factors that can determine the effectiveness of the system and relate to its functioning and use. However, it is worth noting that when forming the EPS portfolio, it is recommended to take into account the fact that a potential client of a trading platform on the EPS market may already use one or more payment systems. Accordingly, the inclusion of each additional EPS in the existing portfolio may bring a potentially smaller number of new users, since some of them are already users of other EPS and this crossover in consumption can be quite high. Accordingly, a part of the unique audience that uses only this EPS and does not use others must be taken into account as a criterion for the effectiveness of the EPS. This forms the direction for further research in this subject area.

The structure of the criteria and determination of the weight of their influence, the establishment of the EPS efficiency evaluation model will differ from the needs of users, and therefore the considered evaluation criteria can be indicative, and the results of the conducted research for trading platforms can provide significant advice for them.

The development of the EPS market is becoming more and more intensive, which requires the search and implementation of new, innovative approaches to the selection of the necessary EPS and the formation of an effective and efficient portfolio. Fuzzy logic methods and expert systems are effective tools for solving the outlined problems, so they are recommended for implementation.

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Вольвач О.

ІННОВАЦІЙНИЙ ІНСТРУМЕНТАРІЙ ФОРМУВАННЯ ПОРТФЕЛЯ ЕПС ДЛЯ ЕЛЕКТРОННИХ ТОРГОВЕЛЬНИХ МАЙДАНЧИКІВ

Коли компанії виходять на ринок електронної комерції, вибір електронної платіжної системи, яка добре поєднується з тим, як вони ведуть свій бізнес, є актуальною і є однією з головних проблем. Усвідомлюючи це, практично всі зацікавлені сторони вивчають різні типи систем електронних платежів і проблеми, пов'язані з системою електронних платежів і цифровою валютою. Це дослідження спрямоване на окреслення інноваційного інструментарію для формування портфеля електронних платіжних систем для сучасних торговельних майданчиків на ринку електронної комерції. Досягнення такої мети передбачає вирішення низки завдань, зокрема висвітлення особливостей застосування систем електронних платежів і критеріїв, які лягають в основу формування ефективного портфеля ЕПС. У межах цього дослідження застосовано багатокритеріальну оптимізацію з використанням методів нечіткої логіки як метод ухвалення рішень, щоб допомогти торговельним майданчикам ухвалити рішення щодо оцінки ефективності ЕПС, формування портфеля електронних платіжних систем та управління ним серед широкого спектра можливих варіантів. Результати дослідження демонструють високу ефективність методів нечіткої логіки, зокрема Fuzzy TOPSIS для досягнення мети дослідження. Сформульовані висновки й рекомендації будуть корисні й з теоретичного, і з практичного погляду для представників е-комерції та наукового товариства з метою розвитку методології управління електронними платіжними системами.

Ключові слова: електронна комерція, портфельна стратегія, електронний торговельний майданчик, електронна платіжна система, інновації, нечітка логіка, математична модель, fuzzy TOPSIS

JEL Класифікація: G14, G31, O31, C10, C13, C52