УДК 621.311 + 658.65.47
JEL L93

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ANALYSIS OF IMPLEMENTING THE ISO 50001:2011 STANDARD IN AVIATION SEGMENT OF TRANSPORT ECONOMY SECTOR

To enhance energy efficiency policy of airports and to reduce their energy consumption the analysis of global experience of implementing the ISO 50001:2011 in aviation segment of transport economy sector was conducted. It was found that at the beginning of 2014, experience in implementing the standard at airports was limited and dissemination and frequency of standard implementation were different for various world economic regions. It was noted that one of the reasons of insufficient dissemination of the standard is the absence of systematization of existing experience that leads to uncertainty of trends in standard dissemination and slows down the decision-making by airport management concerning the standard's implementation. To systematize data, the criteria and relevant to them attributes were defined and substantiated that allowed identifying the trends in disseminating the standard in the aviation sector by criteria of conformity assessment of EnMS with ISO 50001:2011 requirements, socio-economic and operational functions of airports. The prospects of implementing the standard at Ukrainian airports were considered.

Key words: airports, energy management systems, the ISO 50001:2011 standard.

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АНАЛІЗ УПРОВАДЖЕННЯ ISO 50001:2011В АВІАЦІЙНОМУ СЕГМЕНТІ ТРАНСПОРТНОГО СЕКТОРУ ЕКОНОМІКИ

Для посилення політики енергоефективності аеропортів та зменшення енергетичних витрат проведено аналіз світового досвіду впровадження стандарту ISO 50001:2011 в авіаційному сегменті транспортного сектору економіки. Встановлено, що на початок 2014 р. досвід впровадження стандарту в аеропортах залишається обмеженим, причому розподіл та частота впровадження стандарту є нерівномірними за економічними регіонами світу. Зазначено, що однією з причин недостатнього поширення стандарту є відсутність систематизації накопиченого досвіду, що призводить до невизначеності тенденцій розповсюдження стандарту та уповільнює прийняття рішень керівництвом аеропортів стосовно його впровадження. Визначено та обґрунтовано вибір критеріїв і відповідних груп ознак для систематизації даних, що дало змогу сформулювати тенденції поширення стандарту в авіаційному сегменті за критеріями оцінки відповідності системи енергетичного менеджменту вимогам стандарту, соціально-економічного та функціонального призначення аеропортів. Розглянуто перспективи впровадження стандарту в аеропортах України.

Ключові слова: аеропорти, системи енергетичного менеджменту, стандарт ISO 50001:2011.

Problem statement

Sustainable airport development, which becomes one of the key priorities in aviation sector of economy, requires continuous reduction of energy consumption and CO_2 emissions from air transport

infrastructure and integration of low-carbon technologies into airports' activity. The priority of sustainability is caused by increasing the air traffic volume during the last years almost everywhere in the world. In most cases, the energy efficiency of aviation is regarded as improving the efficiency of aircraft operation and optimization of flights. However, growth of passenger and cargo air traffics significantly affects energy consumption of airports, which are part of air transport infrastructure. To operate ground infrastructure and to provide ground handling activity on air traffic service, the level of demand of heat and electricity in modern airports is equal to level of energy demand in small towns. The significant level of energy demand is caused not only by the volume of air traffics; another reason is a high energy intensity of terminals, aerodrome's lighting systems and other facilities of ground infrastructure related to the aircraft maintenance and service of freight and passengers [1]. The methodology and tools of the ISO 50001:2011 "Energy management systems – Requirements with guidance for use" [2] provide conditions to carry out the energy efficiency policy. Thus, implementation of standard will contribute to improving the energy and economic efficiency in aviation sector and to achieving the tasks of sustainable airport development.

Analysis of recent research and publications

The standard ISO 50001:2011 and its basic principles are the most effective tools for attaining the goals of energy efficiency policy at airports; however, the practice on standard implementation in this economy sector is very limited. The previous study has shown that from June 2011, when standard was published, and until the beginning of 2014, broad disseminating the standard in aviation segment of transport economy sector did not occur. According to official statistics of aviation centers, airport authorities, management companies, and certification bodies, there are only 19 airports in the world, where energy management systems (EnMS) passed the conformity assessment in accordance with the standard's requirements [3–7]. These airports' EnMS cover a wide range of activities aimed at energy conservation, energy efficiency and low carbon technologies both for operation of the ground systems and facilities of airport and for providing the ground handling services related to arrival and departure of aircrafts, freights and passengers. According to the airport authorities' conclusions, the EnMS provided the effectiveness of energy policy. The relevancy and balance of managerial, organizational, and technical solutions, aimed at more efficient resource use, were achieved due to the principle of continuous improvement, which is the basis of EnMS. Stable reduction of energy consumption and CO_2 emissions with an increasing a service quality strengthens the airport competitiveness on air transport market and attracts investments. However, despite these benefits, wide implementing the best practices of EnMS did not occur among the airports around the world. One of the reasons is a lack of analysis and systematization of existing experiences that leads to uncertainty regarding trends of standard dissemination and slows down decision-making process about standard implementation by the side of airport authorities.

Objectives

To enhance energy efficiency policy at airports and to reduce their energy consumption the following research objectives were set:

– to carry out statistical analysis of data on implementing the standard in aviation segment of transport economy sector;

– to define criteria for data systematization;

– to identify trends of disseminating the standard in aviation sector according to defined criteria.

Materials

Statistical analysis and systematization of practice of implementing the ISO 50001:2011 at airports in the world. To identify the trends of standard dissemination in aviation economy sector, systematization by qualitative criteria and grouping data by attributes was chosen as research methods. These criteria and attributes characterize a process of standard implementation in air transport

infrastructure and take into account the role of airport as a transportation node. A subject matter of research was the group of 19 airports, where EnMS were assessed accordance with standard requirements.

Criterion of conformity assessment of EnMS with ISO 50001:2011 requirements. The analysis of process of implementing the standard has to reflect its dynamic, methods for assessing the compliance of airport energy policy with ISO 50001:2011 requirements, existence of independent certification bodies with experience in evaluating the airport activities. Thus, to characterize the process of implementing the ISO 50001:2011 the criterion of conformity assessment of EnMS with ISO 50001:2011 requirements was chosen. According to ISO [8], a conformity assessment for management systems can be performed by one of three types of assessment: certification, or the third-party assessment, is performed by independent body with issuing a confirmation (certificate) of compliance with requirements; the second-party assessment is performed and claimed by organization (or person) representing consumers; and the first-party assessment is performed by organization itself and claimed as self-declaration. It is also specified in the standard that a compliance of organization with the standard requirements can be confirmed by self-declaration after self-assessment or by EnMS certification performed by external organization [2]. Thus, according to this criterion, data are grouping by the following attributes: conformity assessment type; organization performed assessment; and year of implementing the standard in airport's activity.

Criterion of socio-economic function of airports. Today, the air transport is one of the most important resources in the global economy. The airports, as transportation nodes, provide significant migration flows (freight and population, including tourism) and trade at the regional, national, and international levels. In 2012, according to International Air Transport Association, a contribution of airports to the global economy was US$ 2.2 trillion: aviation transported 3000 million passengers per annum (mppa), 50 million tons of cargo and supported over 57 million jobs. Economic performance of airports depends on their activity at the world markets, which are typically classified by five socio-economic macro-regions: Asian, Asia-Pacific, American, African, and European. Analysis of distributing the volumes of passenger traffic between the macro-regions and corresponding to them world regions showed that in 2012 the largest annual passenger traffic was carried out in Asia-Pacific macro-region - 947.9 mppa. In American macro-region, the largest passenger traffic was in North America region - 808.1 mppa; in Latin America region - 226.5 mppa. In European macro-region, air traffic volume reached 780.6 mppa. In Asia macro-region, significant volume of air traffic was in West Asia region - 144.1 mppa. In Africa macro-region, air traffic was the lowest one - 69.8 mppa [9]. Typically, ISO standards promote efficiency of companies in international and domestic markets. To identify effect of regional location of airport on the frequency of implementing the ISO 50001:2011, data were grouping by criterion of socio-economic function of airports with using three attributes: macro-region, region, and country.

Criterion of operational function of airports. The last criterion characterizes airport's activities in the field of ground handling services on landing, departure, and maintenance of aircrafts as well as service of passengers, cargo, and mail. This criterion has to describe a scale of airport's activities in aviation market and evaluate a level of operational load of airport; and it is directly related to energy consumption of airports. Initial group of attributes defined by this criterion included the airport categories, number of airlines, and volumes of air traffic for passengers, cargo, and mail. The airport category is qualitative attribute, which determines a scope of airport's activities. Airports are divided by categories into international and domestic ones: international airports provide landing and departure for aircrafts performing international flights and carry out required control (customs, border, sanitary-quarantine, security control, etc.); domestic airports serve aircrafts performing flights only within a country, where airport is located. The level of operational load of airport is determined by quantitative attributes including the air traffic volumes for passengers, cargo and mail, and the number of airlines served at airport. According to the statistics, passenger traffic is dominant one among all other kinds of air traffics, then it is rational to use for systematization the quantitative attributes related to passenger air traffic only. In this case, formally, the number of airlines and number of passengers carried by airlines will define the level of operational load of the airport. By market mechanisms, the passenger air traffic demand and the number of

proposals from airlines are interconnected. Theoretically, these quantitative attributes are dependent each other that allows reducing their number until the one. To find out the actual dependence for group of 19 airports with ISO 50001:2011, the statistical data [4–6] were analyzed. Comparative characteristic of quantitative attributes, in figures 2012, is given in histogram (fig.1).

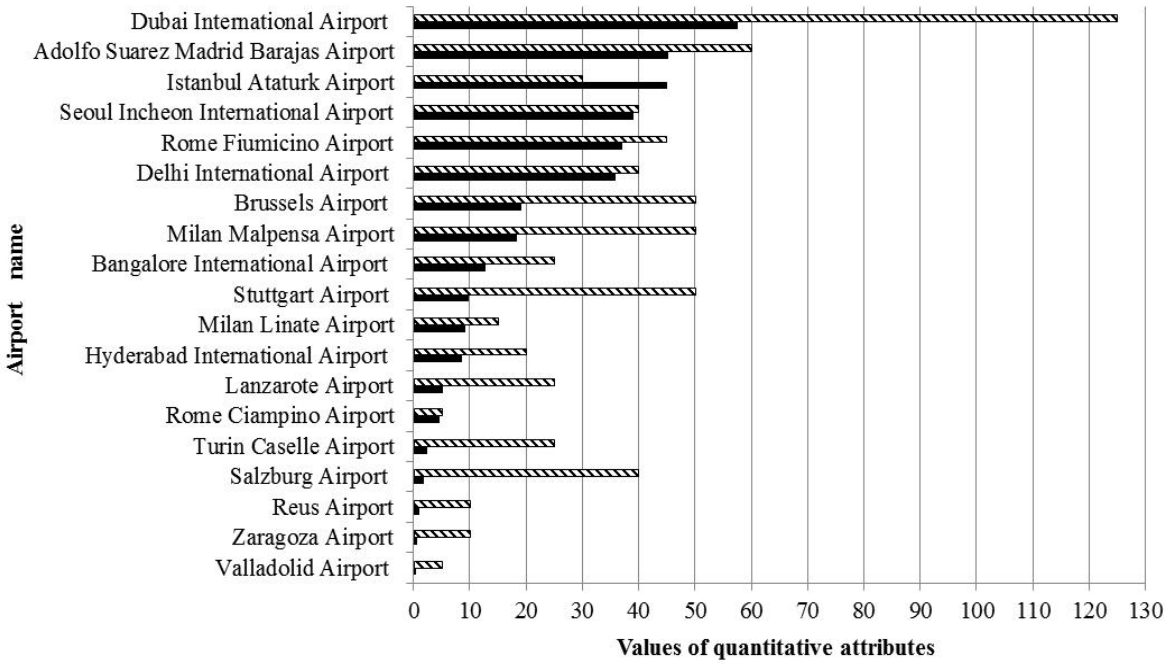

Fig.1. Comparative characteristic of quantitative attributes of annual operational load of airports (2012): ■ *- number of passengers (mppa);* ▧ *- number of airlines*

As shown in fig. 1, there is dependence between two quantitative attributes. To measure a degree of statistical dependence and to define the strength and direction of relationship between the data sets, correlation analysis was applied. According to obtained results the correlation coefficient is $r_{x,y} = +0{,}74$ that means there is a strong positive relationship between variables. The value $r_{x,y}$ is less than 1 because of non-uniform statistics provided by airports about the total number of airlines: some of them include the airlines for scheduled flights only, while the other ones add airlines for season and charter flights.

To determine the significance level (α) of obtained results the significance of correlation coefficient was tested by using t- test. The statistically significant correlation between the number of airlines and number of passengers was found at $\alpha = 0{,}001$. The results of correlation analysis proved the validity of reducing the number of attributes until the one, as well as that volume of passenger traffic is more appropriate option for grouping the data for systematization. This quantitative attribute is connected with dividing the airports into different classes. In accordance with annual volumes of passenger traffic the airports are divided into five classes: I class – 7,0 ÷10,0 mppa; II class – 4,0 ÷7,0 mppa; III class – 2,0 ÷4,0 mppa; IV class – 0,5 ÷2,0 mppa; V class – 0,1 ÷0,5 mppa. The airports, which have more than 10.0 mppa, are defined as airports in excess of classes.

Thus, due to the analysis given above and substantiated reducing the number of attributes affecting operational load of airports, the category and class of airport were selected as the final attributes for grouping data according to the criterion of operational function of airports.

Status and trends of disseminating the ISO 50001:2011 standard in aviation segment of transport economy sector. Systematization and grouping data by defined criteria and attributes were applied to identify the trends of disseminating the standard in the aviation sector.

For further analysis, the data on implementing the ISO 50001:2011 at airports were systematized by the following criteria and attributes.

1. The criterion of conformity assessment of EnMS with the ISO 50001:2011 requirements:

– in accordance with attribute of conformity assessment type, the certification, or the third party assessment, was performed almost in all airports; and there is one case of the first party assessment;

– in accordance with attribute of organization, provided assessment, there are 11 independent certification bodies with experience in auditing the airport's EnMS for compliance with the ISO 50001:2011 requirements;

– in accordance with attribute of year of implementing the standard in airport's activity, in 2011 there were 2 airports; in 2012 – 11 airports, and in 2013 - 6 airports; this dynamic indicates that during the last year dissemination of standard in the aviation sector was slowed down.

2. The criterion of socio-economic function of airports:

– in accordance with attribute of macro-region, there are only three socio-economic macro-regions where the ISO 50001:2011 was implemented at airports: Europe, Asia-Pacific and Asia; and at the beginning of 2014, there are no data about this for American and African macro-regions;

– in accordance with attribute of region, the following regions were identified: Western Europe, Southwest, Eastern and South Asia;

– in accordance with attribute of country, there were only 9 countries identified in the world.

3. The criterion of operational function of airports:

– in accordance with attribute of category of airport, all of the airports were the international ones;

– in accordance with attribute of class of airport, there were 9 airports defined as in excess of classes' range; 3 airports defined as the I-st class; 2 airports defined as the II-nd class; 1 airport defined as the III-rd class; 3 airports defined as the IV-th class and 1 airport defined as the V-th class.

To find out the trends of disseminating the standard the data given above were arranged in context diagrams (Fig. 2). The diagram includes information about macro-regions, regions and countries; list of airports, where the standard was implemented, category and class of airports; conformity assessment type, organization performed assessment and year of implementing the standard in airport's activity. The data cover a period from the date of standard publication in June 2011 to the beginning of 2014. The names of organization performed assessment of EnMS for compliance with the standard requirements are given according to certificates; the airport names are given according to CAPA terminology [5].

Analyzing the data of context diagram, the following trends of implementing the ISO 50001:2011 in the aviation segment for various macro-regions of the world were identified:

– **in European macro-regions (Western Europe),** there was approximately 70 % of the total number of ISO 50001:2011 implementation. During the 2.5 years, the certificates were issued to 13 airports in five countries. The largest number of certificates was issued in Italy and Spain. The standard was implemented both at airports of I-V classes and at airports in excess of classes' range;

– **in Asia-Pacific macro-region (South and East Asia),** there was about 20 % of the total number of certificates issued to 4 airports in two countries (India and South Korea). In September 2011, Delhi International Airport Limited (India) was certified for ISO 50001:2011 and it was one of the first cases in aviation sector. However, then the process of implementing the standard in the region was slowed down: during the last years the certificates were issued to 2 airports in India and to 1 airport in South Korea. These four airports have high level of operational load: three of them are the airports in excess of classes' range and one of them is airport of the I-st class.

– **in Asia macro-region (Southwest Asia),** there were only 2 certificates issued. One certificate was issued in Turkey for airport in excess of classes' range, and another one in United Arab Emirates (UAE) for Dubai Airport Free Zone (DAFZA), which is located within the boundaries of Dubai International Airport.

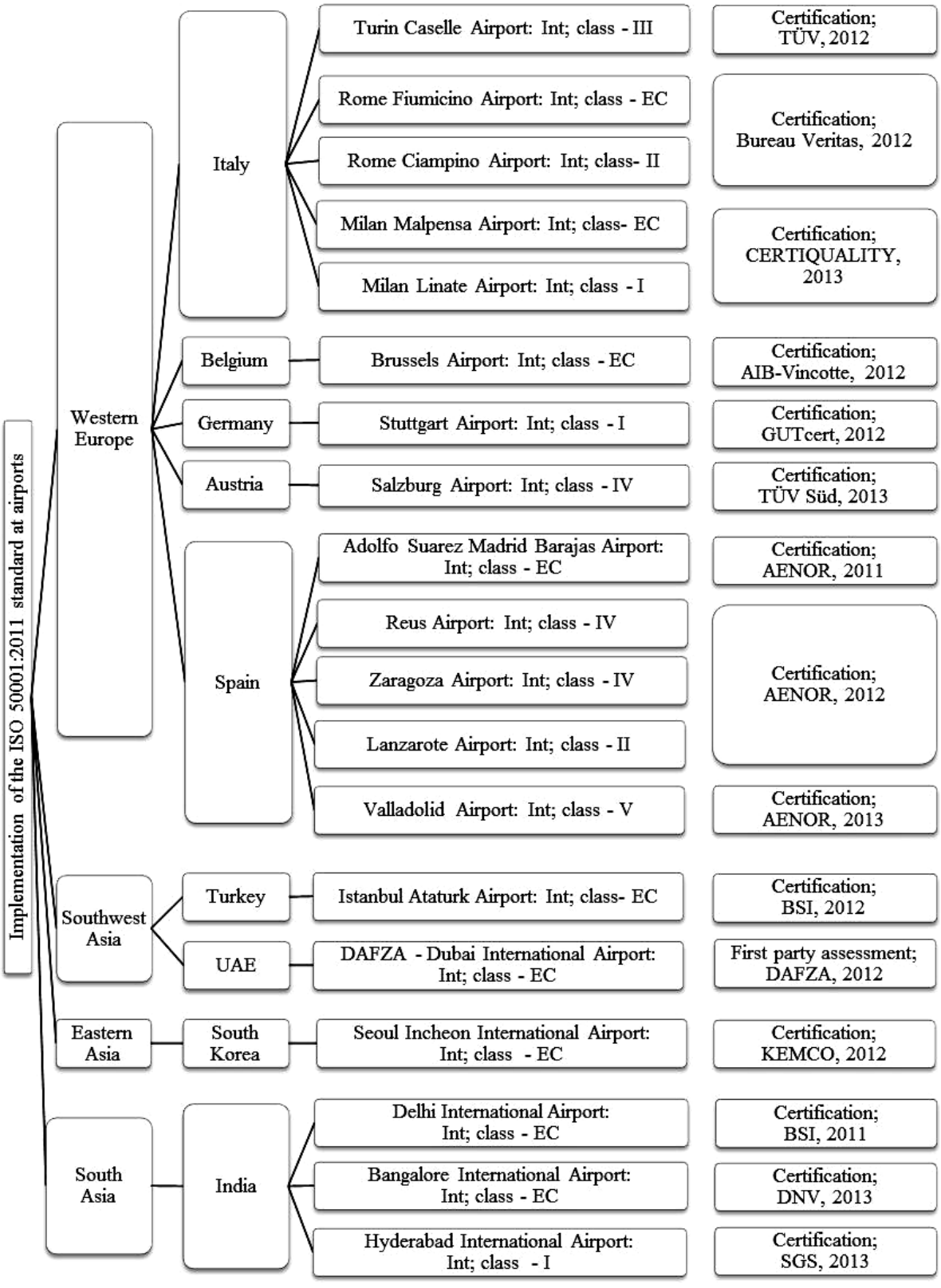

Fig. 2. Systematization of the world practice of implementing the ISO 50001:2011 ("Int" - international category of airport; "class - EC" – airport in excess of classes' range).

Summing up the results of the analysis it may be noted that countries of European macro-region have the best experience in implementing the standard. Their practice of certification covers all levels of operational load of airports by the class and has the highest representativeness on auditing the airport's EnMS for compliance with ISO 50001:2011 by independent certification bodies.

Conclusions

The results of the statistical analysis have shown that at the beginning of 2014 the experience in implementing the ISO 50001:2011 standard at the airports was limited; it only existed at 19 airports in nine countries, and the dissemination and frequency of implementing the standards were different for various economic regions in the world. Based on the analysis of global experience, structuring data and correlation analysis the qualitative criteria have been defined. These qualitative criteria and relevant to them attributes characterize both the process of standard implementation in air transport infrastructure and the activities of airports as transportation nodes. It allows systematizing the data of implementing the standard by criteria of conformity assessment of EnMS with standard requirements; socio-economic and operational functions of airports. Due to this approach, the trends of implementing the ISO 50001:2011 in the aviation segment of transport economy sector have been identified.

Prospects for future research

The signing an agreement on a Common Aviation Area between Ukraine and European Union in the near future will considerably affect the aviation market. Growing the number of airlines and volumes of air traffic will essentially increase a level of operational load of Ukrainian airports. To be competitive on international aviation markets the national civil aviation enterprises should be modernized to develop them according to the principles of sustainable airports. In this context, a system approach in reducing the energy consumption is possible through the implementing the ISO 50001:2011 in Ukrainian airports. The airports have significant potential for energy savings in heating, air conditioning and ventilation, indoor and outdoor lighting (terminals, vehicles parking, and advertising spaces), water supply, etc. In order to promote the standard implementation at Ukrainian airports it is necessary to determine areas of airport's activities, which are the most cost-effective for EnMS.

1. Методологічні аспекти підвищення енергоефективності функціонування аеропортів у контексті сталої авіації / Г.Г. Стрелкова, Г.М. Агєєва // Архітектура та екологія: V Міжнар. наук.-практ. конф., 29-30.10.2013 р.: матеріали конф. – К.: НАУ, 2013. – Ч.ІІ. – С. 119–122. 2. ISO 50001:2011. Energy management systems – Requirements with guidance for use. – CEN/CENELEC. – European Committee for Standardization. – 2011. – 22 p. 3. Досвід сертифікації систем енергетичного менеджменту об'єктів інфраструктури авіаційного транспорту за вимогами стандарту ISO 50001 / Г.Г. Стрелкова, Г.М. Агєєва // Енергетичний менеджмент: стан та перспективи розвитку. – 2014: І Міжнар. наук.-практ. та навч.-метод. конф., 27–29.05.2014 р.: матеріали конф. – К.: НТУУ "КПІ", 2014. – С. 64–65. 4. Eurostat Website: Data on Transport statistics. Transport Database [Electronic resource]. − Access mode: http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database 5. CAPA - Centre for Aviation. Airports [Electronic resource]. − Access mode: http://centreforaviation.com/ 6. Airports Council International. Airport Statistics and Data Centre [Electronic resource]. − Access mode: http://www.aci.aero/Data-Centre 7. ISO 50001:2011. Энергоменеджмент. Международная сертификация [Electronic resource]. − Access mode: http://www.gost50001.ru/mezhdunarodnaya-sertifikatsiya 8. ISO. Standards. Management system standards [Electronic resource]. − Access mode: http://www.iso.org/iso/ru/home/standards/management-standards.htm 9. IATA. Publications. World Air Transport Statistics (WATS) [Electronic resource]. − Access mode: http://www.iata.org/publications/Pages/wats.aspx.