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OPTIMIZING THE PROCESS OF DEFINING AREAS OF RESPONSIBILITY IN THE CONTEXT OF SMALL AIRCRAFT LEASING USING EAM SYSTEMS

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Abstract. This study focuses on optimizing the process of defining responsibility zones within the context of leasing for small aviation using an Enterprise Asset Management (EAM) system. The management of responsibility zones is crucial in the leasing process of small aviation, and the application of EAM systems enhances efficiency. The paper examines the complexities involved in determining responsibility zones and proposes an innovative conceptual model that leverages EAM technology. The model facilitates the accurate allocation of responsibilities, streamlines leasing operations, and contributes to the overall efficiency of the small aviation leasing industry. The practical significance of this research lies in its potential to enhance the precision and effectiveness of responsibility zone determination, ultimately benefiting the management of small aviation leasing operations.

Keywords: small aviation, leasing operations, areas of responsibility, EAM systems, asset management

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ОПТИМИЗАЦИЯ ПРОЦЕССА ОПРЕДЕЛЕНИЯ ЗОН ОТВЕТСТВЕННОСТИ В КОНТЕКСТЕ ЛИЗИНГА МАЛОЙ АВИАЦИИ С ПОМОЩЬЮ EAM-СИСТЕМ

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Аннотация. Данное исследование посвящено исследованию оптимизации процесса определения зон ответственности в рамках лизинга для малой авиации с использованием системы управления активами предприятия (EAM). Управление зонами ответственности имеет решающее значение в процессе лизинга для малой авиации, и применение EAM-систем повышает его эффективность. Актуальность данного исследования заключается в возможности повысить точность и эффективность определения зон ответственности, что в конечном итоге благоприятно скажется на управлении лизинговыми операциями малой авиации. В статье рассматриваются сложности, связанные с определением зон ответственности, и предлагается инновационная концептуальная модель, использующая технологию EAM. Модель способствует точному распределению обязанностей, оптимизирует лизинговые операции и повышает общую эффективность лизинговой отрасли малой авиации.

Ключевые слова: малая авиация, лизинговые операции, зоны ответственности, EAM-системы, управление активами

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Introduction

In the modern world, the development of the aviation industry is becoming a key factor for ensuring global economic integration and socio-cultural development. An important component of this industry is small aviation, which has significant advantages in mobility and communication, providing transportation of passengers and cargo to remote regions with limited access. There is a great potential for the development of small aviation in Russia, which is the only means of transport accessibility in most parts of the country and in many regions is the dominant component of the transportation system. Nevertheless, there are only 3.1 small aircraft per 100 thousand people, which indicates a low level of development of this industry (Petrenko, 2016; Prosvirina, 2020; Sokolov, 2007). The results of the analysis of the state of civil aviation in Russia and the prospects for the development of air transportation emphasize the need to find technical and financial solutions to meet the needs of operators and aircraft manufacturers. Aircraft fleet renewal requires significant investments, and leasing is the most promising form of investment activity for civil aviation. Foreign statistics shows that more than half of aircraft in the world are acquired through leasing transactions.

The development of leasing operations in the Russian market began since the inclusion of the term "Leasing" in the Civil Code of the Russian Federation in 1995. The law "On Financial Lease (Leasing)" in the edition of 04.11.2014 N 164-FZ regulates this sphere, considering changes and additions since its adoption in October 1998 (Federal Law of October 29, 1998). This law provides a definition of the term "leasing" as a set of economic and legal relations arising under a leasing agreement, which includes the acquisition of the leasing object. The leasing agreement, in turn, is an agreement under which the lessor undertakes to purchase property from the seller and provide it to the lessee for temporary possession and use for a fee.

To date, the concept of "Aviation leasing" is widespread, which is a specific type of leasing, where the objects are aircraft together with the relevant infrastructure and equipment. The main principles of aviation leasing organization include urgency, payment, and cost-effectiveness. Based on these principles it is possible to formulate the essence of aviation leasing as a complex economic and legal relations between three main subjects: lessor, lessee, and seller (Kabirov, 2017; Efimov, 2010; Dun, 2012). Within the framework of such relations the investing leasing company acquires a certain aircraft or other aviation property from a particular manufacturer and provides this property for temporary possession and use to the lessee for regular leasing payments. At the same time, such a scheme provides an opportunity for commercial flights and provides for the transfer of ownership in the future.

Comparing aircraft leasing with other delivery schemes, the following advantages can be emphasized (Baeva and Ismagilova, 2023; Buryatin, 2019; Dobrovolsky, 2011):

1. A flexible payment scheme in which the bulk of the payments can be deferred to a later period. This is especially relevant for aircraft which, after a long period of use on route networks, begin to bring more significant profit;
2. Absence of the aircraft on the airline's balance sheet, which excludes an increase in its assets and exempts it from paying property tax;
3. Exposure of aircraft, acting as objects of leasing, to accelerated depreciation.

To solve this problem, it is proposed to investigate the potential of applying advanced Enterprise Asset Management (EAM) technology in small aviation. EAM systems, with their high efficiency, can significantly contribute to improving the transparency, control, and coordination of asset management processes, including aircraft and related equipment. By systematically analyzing data on the condition, maintenance and operation of aircraft, EAM systems not only provide more accurate information on the current condition of assets and their technical readiness, but also have the potential to be a powerful tool for analyzing incidents, identifying root causes, and determining responsible parties.

Materials and Methods

Digital transformation and the introduction of the latest technologies have become an important factor in today's aviation industry, including small aviation. As part of the drive to optimize asset management processes and improve aircraft lifecycle efficiency, aviation companies are increasingly turning their attention to CALS (Continuous Acquisition and Lifecycle Support) technologies. CALS technology is a concept and methodology for product lifecycle management, including the phases of development, production, operation and maintenance (Sazonov et al., 2018). In small aviation CALS-technologies are of special importance, as they allow to optimize asset management, perform operational control over aircraft condition and improve coordination of work of all links of the production process. At the same time, CALS technologies provide a unified information environment for collecting, storing and analyzing data on aircraft operation and maintenance (Zaitsev, 2022). This integration of data from various life-cycle participants creates a single information resource available to all stakeholders. This provides transparency and accuracy of data, which can simplify the process of determining responsibility when incidents or accidents occur.

One of the representatives of CALS-technologies in the field of asset management is EAM-systems. EAM focuses on the effective management of enterprise assets throughout their life cycle, including equipment, machinery, vehicles and other physical assets. It is a complex integrated software specifically designed for the management of physical assets of enterprises, allowing to automate maintenance and repair (MRO) processes, modernize the processes of repair and maintenance management of equipment to improve their efficiency, as well as integrating all participants of the life cycle within a single information field. EAM is a continuation and development of the Asset Management concept, which was introduced by international standards of ISO 55000 series (ISO 55000:2014). The system helps to increase the efficiency of processes, reduce the probability of downtime and maintain maximum availability of equipment, which ultimately reduces the cost of its operation and increases the profitability of the enterprise.

EAM provides a wide range of tools for equipment and infrastructure management, including (Antonenko, 2015; SMB-Test, nd.):

1. Inventory and spare parts management. EAM allows to optimize inventory and spare parts management, minimizing the costs of their storage and acquisition. The system helps determine optimal inventory levels based on equipment utilization and forecasting;
2. Technical Data Management. EAM allows you to store and manage all necessary information on equipment specifications, including operating instructions, technical drawings, schematics, etc.;
3. Preventive maintenance and repair management. With EAM you can create and plan preventive maintenance and repairs of equipment based on its technical condition, as well as monitor their fulfillment;
4. Monitoring and evaluation of equipment technical condition. EAM allows you to collect and analyze data on the condition of equipment, which allows you to determine the need for preventive maintenance and repair;
5. Application of technology of technical condition forecasting. On the basis of data analysis the system allows to plan maintenance of units and equipment in advance;
6. Spare parts and materials order management. With the help of EAM it is possible to create and track orders for spare parts and materials, as well as to control their fulfillment;
7. Documentation Management. EAM allows you to store and manage all necessary documentation related to equipment and infrastructure, including quality certificates, warranties, etc.;
8. Analytics and Reporting. EAM allows you to analyze data on equipment and infrastructure usage, evaluate their efficiency and identify areas for improvement. The system also provides extensive reporting and dashboarding capabilities;
9. Efficient management of assets and maintenance processes with a single hub for asset and equipment information.

Before analyzing the application of EAM technologies to the task of defining areas of responsibility, specialized software modules and system features that optimize multiple phases of the aircraft life cycle should be studied.

First, EAM provides a system for aircraft condition analytics and event forecasting that takes as input data from aircraft sensors based on IoT technologies, as well as business data containing information on operating modes and maintenance activities (Ivanov et al., 2018; Stepanova, 2014). Collecting and combining such a wide layer of data in a single information environment allows analysis in new and more detailed sections of information, realizing Condition Based

Maintenance (CBM) and Predictive Maintenance (PdM) strategies.

CBM, or Condition Based Maintenance, allows maintenance of equipment based on its actual condition and performs work only when there are certain signs of malfunction or wear of on-board equipment (Rodionov and Kalinina, 2014). In turn, PdM, or predictive maintenance method, uses data analysis to predict the need for maintenance or parts replacement before clear signs of failure occur. In this way, the operator can supplement traditional preventive maintenance and condition-based inspections with more accurate and effective strategies that can be used to inform Maintenance Programs and Plans.

EAM also includes an Asset Strategy and Performance Management solution that provides specialized tools that support all types of analysis in use - RCA, RCM, FMEA and PM Review (SAP, nd). The specialized tools in EAM are highly accurate and focused on specific tasks. For data analysis, the system provides quality and reliable information because data is collected and analyzed automatically. The high reliability of the tools is also due to the use of new aircraft condition analytics technology, which provides valuable information for further analysis of system reliability and finding the causes of failures. Moreover, the system allows for the integration of analytical results with other modules, which facilitates equipment management and reduces decision-making time. The software module also allows you to create effective reliability-oriented Maintenance Programs and Plans based on the analysis performed by the tools (Sharafeev and Ermolenko, 2013). This approach ensures continuous monitoring and continuous improvement of the Maintenance Program, allowing you to balance maintenance costs against risks. Thus, it is possible to achieve a more efficient use of resources and reduce the probability of breakdowns and costly repairs.

As part of the system, a joint asset management service has been implemented, providing the possibility of information exchange between the operator and the equipment manufacturer within a single network channel, which allows them to have access to a "single version of the truth", i.e., to a common database with information on assets. This simplifies the process of interaction and collaboration between the operator and manufacturer and ensures harmonized processes across a single business network. As a result, the operator and manufacturer can exchange information on asset condition, failures, spare parts and maintenance recommendations more quickly and accurately. This approach increases the efficiency of work, reduces the time for information retrieval and transfer, and improves the quality of aircraft repair and maintenance.

Integration of EAM-system with ERP allows planning of MRO, equipment, and repair crews to perform the planned work. All information flows are synchronized between the systems, which allows to improve the efficiency of aircraft repair and maintenance management, reduce downtime, increase aircraft availability, and optimize the level of resources and stocks in warehouses required for aircraft maintenance. A set of procedures implemented with the help of EAM allows to build a process in full compliance with the concept of integrated logistics support, allowing to improve the efficiency and optimization of MRO processes, as well as to increase the level of transparency and coordination of all stakeholders.

Results and Discussion

As mentioned earlier, EAM is a set of technologies that collect, store and analyze data from all participants in the aircraft lifecycle. These technologies are mainly used to optimize asset management and provide better control over maintenance and operations processes (Ilin et al., 2017; Kuzmenko, 2018). However, the potential of EAM can also be applied to analyze the determination of liability for incidents and accidents in small aviation. Focusing on the issue of liability, it is worth noting that the delineation of liability for various events and incidents between life-cycle participants is based on unique contractual provisions. These provisions are developed by experts individually for each leasing company and there may be many variants of liability delimitation. Therefore, this paper will not focus on examples of specific delineations, as the primary and most difficult task is to establish the causes of incidents, after which identifying the responsible party is a relatively trivial task. Instead, the focus will be on analyzing the potential of applying EAM systems to situations that are of concern to leasing companies due to the difficulty of determining root causes and gathering evidence, namely, parts failures and airplane crashes.

Airplane crashes, in addition to the tragic consequences for people, also have huge financial implications. The loss of aircraft, passengers and cargo is accompanied by significant costs for compensation, investigations and possible lawsuits. Part failures also pose a significant threat to flight safety and efficiency (Makhotkin, 2008; Martirosyan and Pavlyuk, 2018). Despite rigorous technical inspections and maintenance, even the smallest defects can lead to serious consequences and costly repairs. Considering the above situations, it is necessary to highlight the main causes of their occurrence in order to further explore the possibilities of their identification based on the components of EAM systems.

Aircraft crashes occur due to diverse reasons, such as:

1) Technical Failures: One of the main factors causing airplane crashes is technical failures of aircraft or aircraft components. Malfunctions in engines, control systems, fuel systems, and other critical components can lead to loss of control of the airplane and crash;

2) Manufacturing Defects: Defects discovered during the manufacturing of aircraft or aircraft parts can lead to serious consequences during operation. Problems with materials, assembly, or quality can lead to unexpected failures;

3) Improper operation: Piloting errors and improper handling of aircraft is another common cause of airplane crashes. Incorrect maneuvers, improper takeoff and landing procedures, and failure to follow safety protocols can cause serious incidents;

4) Weather: Extreme weather conditions such as high winds, thunderstorms, icing, and poor visibility can severely impact flight safety. Uncontrolled changes in weather can cause piloting difficulties and lead to airplane crashes.

Parts failure:

1) Manufacturing defects: Defects that occur during the manufacturing of parts or equipment can be a source of unpredictable failures during operation. Poor quality materials or assembly can lead to serious consequences;

2) Wear and Aging: Constant use and operation of aircraft causes parts to wear and tear. Over time, defects and damage can occur that can cause breakdowns;

3) Failure to keep up with maintenance: Failure to perform regular maintenance and repairs can lead to degradation of parts and equipment. The need for replacement or repair can occur suddenly, increasing the risk of accidents;

4) Maintenance error: Improper maintenance and repair can also lead to parts failure. Improper installation or adjustment of parts can lead to defects and additional problems;

5) Exposure to external factors: Aircraft can be exposed to various external factors such as weather conditions, mechanical damage, and others. These factors can cause parts and equipment failure, even during normal operation.

In order to better understand the relationship between the incident that occurred and various factors, and to prevent similar incidents in the future, companies need to conduct detailed analysis using a variety of methods and available data (James and Lee, 2004). In this context, EAM systems have significant potential for structuring and analyzing aircraft information. The set of tools used in such systems allows for a deeper understanding and analysis of the events and possible causes that influenced the development of the incident (see table 1).

Table 1. The capabilities of EAM systems and their potential application for incident root cause analysis

Analysis tools	Application potential
Base of analytics of the state of AF components	An aircraft component condition analytics database can be consulted to analyze the incident that occurred. This database may contain historical data on the condition of parts and components, showing signs of degradation or anomalies that may have led to the incident. Using this data, it is possible to determine if there were any warning signals of a possible failure.
Collection of maintenance and operational data	Information on routine maintenance, parts replacement and operating conditions helps to understand what actions were taken prior to the incident and under what operating conditions. This data may indicate inadequate maintenance, missed inspections, failure to observe weather conditions or other factors that may have affected flight safety.
Collecting data from component manufacturers	In the event of an incident, access to parts data from component manufacturers can be quickly established. This data may include documentation, technical specifications, operating recommendations, and other details. Analysis of this data can identify possible scenarios related to component defects or events that may have contributed to the incident that occurred. Additionally, this analysis can lead to the identification of causal factors such as manufacturing defects or defects that may have been inherent in a particular batch of parts.
Information on RCM analysis results and developed Maintenance Programs	The results of the reliability analysis as well as the MRO program can be valuable in analyzing incidents that have occurred. By correlating the data from the RCM analysis with the actual incident events, it can be determined whether the risks and potential causes of failure have been addressed in the applicable Maintenance Program.
Digital twin	Using a digital twin of aircraft and components, a virtual simulation of an incident can be conducted. This will help to understand what parameters and scenarios could have led to the incident and what changes in conditions could have prevented it from occurring.

After identifying the main factors contributing to incidents and determining the available analysis tools within EAM systems, it is important to correlate them (see table 2 and table 3). In the case of leasing companies focused on the provision of aircraft for operation, this systematization may have important practical applications.

Table 2. A comparison of the causes of airplane crashes and potential root cause analysis tools

Possible causes	Analysis tools	Rationale for use of the tool
Technical faults	Aircraft component condition analytics database	Analyzing historical data on the condition of parts and assemblies can identify signs of degradation or anomalies that may have contributed to technical failures.
	Collection of maintenance and operational data	Information on maintenance performed and parts replaced may indicate failure to perform regular maintenance or insufficient attention to the condition of components, which may have led to technical faults.
	Data collection from component manufacturers	Analyzing parts data and specifications from manufacturers allows you to identify defects or inconsistencies that may have caused technical malfunctions.
	Information on RCM analysis results and developed Maintenance Programs	Analysis of unaccounted risks or inaccuracies in the design of the Maintenance Program may explain the cause of the technical failure of the equipment.
Manufacturing defects	Data collection from component manufacturers	Manufacturing performance and component inspection data can reveal the presence of defects made at the manufacturing stage.
	Base of analytics of the state of AF components	Analysis of historical data on the condition of parts and units allows to identify signs of early degradation of elements earlier than the manufacturer's stated period of time.

Possible causes	Analysis tools	Rationale for use of the tool
Improper use	Base of analytics of the state of AF components	Historical data on operating modes can help identify non-standard utilization scenarios that may have led to improper operation and airplane crashes.
	Collection of maintenance and operational data	Identification of discrepancies in the validity of data on maintenance performed and operating modes may signal the cause of an airplane crash.
Weather conditions	Base of analytics of the state of AF components	Data on component response to extreme weather conditions can help identify which components suffered degradation due to weather factors that may have led to the airplane crash.
	Collection of maintenance and operational data	Data on aircraft operating modes and conditions can help identify situations in which aircraft crashes have occurred due to operation in hazardous weather conditions.
	Digital twin	Virtual simulation of flight scenarios in different weather conditions allows us to determine which parameters could have influenced the occurrence of an airplane crash in extreme weather conditions.

Table 3. Comparison of causes of aircraft parts failures and potential root cause analysis tools

Possible causes	Analysis tools	Rationale for use of the tool
Manufacturing defects	Data collection from component manufacturers	Part documentation and performance data can reveal defects or inconsistencies that were inherent in the parts at the manufacturing stage and may have caused a defect.
	Base of analytics of the state of AF components	Analysis of historical data on the condition of parts and units allows to identify signs of early degradation of elements earlier than the manufacturer's declared period.
Wear and aging	Base of analytics of the state of AF components	Historical data on the condition of parts can reveal the extent of wear and degradation, which can be the cause of failures due to aging components.
	Collection of maintenance and operational data	Data on regular replacement and maintenance of parts can indicate the extent of wear and areas requiring special attention. Lack of replacements can lead to unacceptable wear and ageing, increasing the risk of failure.
Failure to comply with maintenance schedules	Collection of maintenance and operational data	Failure to meet maintenance schedules can lead to component degradation and increase the likelihood of failure. Analyzing maintenance and replacement data can help you determine if failure to meet maintenance schedules was the cause of failures.
Service error	Base of analytics of the state of AF components	Historical data on the condition of parts and assemblies can reveal inconsistencies and defects that may have occurred due to errors in previous maintenance or repairs.
	Collection of maintenance and operational data	Missing maintenance records or improperly performed maintenance can lead to defects and part failures. Analyzing maintenance records can reveal errors and inconsistencies that caused the failure.
Impact of external factors	Base of analytics of the state of AF components	Data on how parts react to external factors, such as mechanical damage or weather conditions, can reveal which components have been affected and may have caused failure.
	Digital twin	Virtual simulations of the effects of various external factors on components provide insight into what exposure scenarios may have caused parts and equipment failures.

The application of the presented methodology for analyzing incidents and aircraft breakdowns using EAM-systems tools opens up significant prospects for improving safety and reliability in the aviation industry. The integration of data on component status, maintenance, reliability analysis and other aspects into a single information space facilitates a deeper and more systematic analysis of the events that occurred. This approach not only identifies the specific causes of incidents, but also the context and interrelationships between the various factors.

Moreover, the use of this methodology can have a significant impact on determining the degree of responsibility for incidents and breakdowns. A systematic analysis based on objective data helps to better identify those responsible for the events that occurred, helping to prevent unfounded accusations and provide an objective evidence base.

Conclusion

This paper presented a methodology for analyzing aircraft incidents and breakdowns, taking into account the active use of EAM-systems tools. Analyzing the main causes of aircraft accidents and parts defects, an approach was developed focused on systematization and analysis of data received from various participants of the aircraft life cycle. The merging of this information into a single information platform enables systematic and in-depth analysis of the events that occurred. This new perspective of data utilization allows the identification of not only the surface causes, but also the root causes of incidents, contributing to a more complete understanding of the context and dynamics of events.

Of particular note is the ability of this methodology to have a significant impact on the process of identifying responsible parties for incidents and defects. A more accurate and objective analysis based on concrete data serves as a safeguard against unfounded accusations and provides an objective basis for identifying actual responsibility. These measures contribute to a more balanced and fair mechanism for determining the guilty parties.

Thus, the use of the proposed incident analysis methodology with the integration of EAM systems opens new horizons for improving the efficiency and confidence of leasing companies in small aviation. This approach facilitates more in-depth and detailed analysis of events, accurate determination of actual responsibility and, as a result, contributes to further improvement of the small aircraft operation system.

REFERENCES

Antonenko I.N. 2015. TRIM EAM system: from MRO automation to asset management. Automation in Industry, 1, 40–43.

Baeva M.A., Ismagilova O.D. 2023. The global aviation leasing market and the participation of Russian companies in it. Economic development of Russia, 2 (30), 4–15.

Buryatin M.M. 2019. Global civil aviation market: current state and development forecast. Bulletin of Eurasian Science, 1 (11), 7.

Dobrovolsky V. 2011. Leasing in aviation: current trends. Leasing. 10, 22-29.

Dun I.R. 2012. Leasing in the aviation industry. Leasing. 5, 25-28.

Efimov V.V. 2010. Features of ensuring the safe operation of helicopters with externally loaded cargo. Scientific Bulletin of the Moscow State Technical University of Civil Aviation, 151, 124–129.

Federal Law of October 29, 1998 No. 164-FZ “On financial rent (leasing)”. Information and legal portal "Garant". – Last updated 02/19/2014.

Ilin I.V., Levina A.I., Shirokova S.V., Ilyashenko O.Yu., Dubgorn A.S. 2017. Enterprise architecture: interdisciplinary case study.

ISO 55000:2014 “Asset management - Overview, principles and terminology”. IDT, 2014. 19 p.

Ivanov I.M., Viktorov D.S., Bondarev V.N. 2018. Analysis of aviation events with state aircraft of the Russian Federation due to failures of avionics for the period 2000-2017. Journal of the Siberian Federal University. Engineering and Technology, 7(11), 775–782.

James J., Lee N. 2004. Root Cause Analysis for Beginners. Quality basics, 37(7), 45-53.

Kabirov M. A. 2017. On the issue of terminology and qualifications of small aviation. Prospective directions of socio-economic development of Russia: Collection of articles based on the materials of the IV annual scientific and practical conference, Moscow, November 29,

2017. Moscow: Limited Liability Company "Scientific Consultant". pp. 48-52.
Kuzmenko N.A. 2018. Analysis of the principles of formation of the architectural environment of small aviation objects. Formation of the subject-spatial environment of a modern city: Collection of materials of the annual All-Russian scientific and practical conference (with international participation), Magnitogorsk, November 01–02 2018. – Magnitogorsk: Magnitogorsk State Technical University named after. G.I. Nosova. pp. 16-22.
Martirosyan T.E., Pavlyuk A.V. 2018. Issues of delimitation of civil liability in the event of a plane crash. Problems of economics and legal practice, 1, 83–87.
Makhotkin A.A. 2008. Problems of implementing aircraft leasing in Russia. Flight, 7(2), 178–179.
Petrenko I.F. 2016. The great importance of small aviation. Transport strategy - XXI century. 33, 50-51.
Prosvirina N.V. 2020. Analysis of the problems of small aviation in Russia and possible ways to solve them. Natural Sciences and Humanities Studies, 2(28), 232–238.
Rodionov V.V., Kalinina I.E. 2014. Information system for organizing small aviation flights. Search for effective solutions in the process of creating and implementing scientific developments in the Russian aviation and rocket and space industry: International scientific and practical conference, Kazan, August 05–08, 2014. Volume II. – Kazan: Publishing House of Kazan State Technical University. P. 579-581.
SAP, nd. Asset Management - Enterprise Asset Management (EAM) [Electronic resource]. URL: https://www.sap.com/products/scm/asset-management-eam.html (las accessed: 22.07.2023).
Sazonov A.A., Jamai V.V., Povekvechnykh S.A. 2018. Analysis of the effectiveness of implementing CALS technologies (using the example of the domestic aircraft industry). Production Organizer, 1 (26), 84–92.
SMB-Test, nd. EAM systems for small and medium-sized businesses [Electronic resource]. URL: https://smb-test.ru/eam/ (date of access: 07/24/2023).
Sokolov S.A. 2007. Current state of the Russian aviation industry and trends in the development of small aviation. Questions of economic sciences. 2 (24), 167-171.
Stepanova N.I. 2014. Economics of Civil Aviation. M.: MSTU GA, 621 p.
Sharafeev I.Sh., Ermolenko I.V. 2013. Analysis of the organization of production of small aircraft. News of higher educational institutions. Aviation technology. 4, 55-58.
Zaitsev A.Y. 2022. Implementation of project and process management in mining enterprises. Technoeconomics. 2 (2). 12–20. DOI: https://doi.org/10.57809/2022.2.2.2

СПИСОК ИСТОЧНИКОВ

Антоненко И.Н. 2015. EAM-система TRIM: от автоматизации ТОиР к управлению активами. Автоматизация в промышленности, 1, 40–43.
Баева М.А., Исмагилова О.Д. 2023. Мировой рынок авиационного лизинга и участие в нем российских компаний. Экономическое развитие России, 2 (30), 4–15.
Бурятин М.М. 2019. Мировой рынок гражданской авиации: текущее состояние и прогноз развития. Вестник евразийской науки, 1 (11), 7.
Добровольский В. 2011. Лизинг в авиации: актуальные тенденции. Лизинг. 10, 22-29.
Дун И. Р. 2012. Лизинг в авиационной промышленности. Лизинг. 5, 25-28.
James J., Lee N. 2004. Root Cause Analysis for Beginners. Quality basics, 37 (7), 45-53.
Ефимов В.В. 2010. Особенности обеспечения безопасности эксплуатации вертолетов с грузом на внешней подвеске. Научный вестник Московского государственного технического университета гражданской авиации, 151, 124–129.
Федеральный закон от 29.10.1998 г. № 164-ФЗ «О финансовой аренде (лизинге)». Информационно-правовой портал «Гарант». – Последнее обновление 19.02.2014.
Ilin I.V., Levina A.I., Shirokova S.V., Ilyashenko O.Yu., Dubgorn A.S. 2017. Enterprise architecture: interdisciplinary case study.
ISO 55000:2014 «Asset management - Overview, principles and terminology». IDT, 2014. 19 p.
Иванов И.М., Викторов Д.С., Бондарев В.Н. 2018. Анализ авиационных событий с

государственными воздушными судами РФ из-за отказов бортового радиоэлектронного оборудования за период 2000-2017 гг. Журнал Сибирского федерального университета. Техника и технологии, 7 (11), 775–782.

Кабиров М.А. 2017. К вопросу о терминологии и квалификации малой авиации. Перспективные направления социально-экономического развития России : Сборник статей по материалам IV ежегодной научно-практической конференции, Москва, 29 ноября 2017 года. Москва: Общество с ограниченной ответственностью "Научный консультант". 48-52.

Кузьменко Н.А. Анализ принципов формирования архитектурной среды объектов малой авиации. Формирование предметно-пространственной среды современного города : Сборник материалов ежегодной Всероссийской научно-практической конференции (с международным участием), Магнитогорск, 01–02 ноября 2018 года. Магнитогорск: Магнитогорский государственный технический университет им. Г.И. Носова. 16-22.

Мартиросян Т.Э., Павлюк А.В. 2018. Вопросы разграничения гражданско-правовой ответственности в случае авиакатастрофы. Проблемы экономики и юридической практики, 1, 83–87.

Махоткин А.А. 2008. Проблемы реализации лизинга воздушных судов в России. Полет, 7 (2), 178–179.

Петренко И.Ф. 2016. Большое значение малой авиации. Транспортная стратегия - XXI век. 33, 50-51.

Просвирина Н.В. 2020. Анализ проблем малой авиации в России и возможные пути их решения. Естественно-гуманитарные исследования, 2 (28), 232–238.

Родионов В.В., Калинина И.Е. 2014. Информационная система для организации полётов малой авиации. Поиск эффективных решений в процессе создания и реализации научных разработок в российской авиационной и ракетно-космической промышленности : Международная научно-практическая конференция, Казань, 05–08 августа 2014 года. Том II. Казань: Издательство Казанского государственного технического университета. 579-581.

SAP. Asset Management - Enterprise Asset Management (EAM) [Электронный ресурс]. URL: https://www.sap.com/products/scm/asset-management-eam.html (дата обращения: 22.07.2023).

Сазонов А.А., Джамай В.В., Повеквечных С.А. 2018. Анализ эффективности внедрения CALS технологий (на примере отечественного авиастроения). Организатор производства, 1 (26), 84–92.

SMB-Test. EAM-системы для малого и среднего бизнеса [Электронный ресурс]. URL: https://smb-test.ru/eam/ (дата обращения: 24.07.2023).

Соколов С.А. 2007. Актуальное состояние российской авиационной промышленности и тенденции развития малой авиации. Вопросы экономических наук. 2 (24), 167-171.

Степанова Н.И. 2014. Экономика гражданской авиации. М.: МГТУ ГА, 621 с.

Шарафеев И.Ш. 2013. Анализ организации производства летательных аппаратов малой авиации. Известия высших учебных заведений. Авиационная техника. 4, 55-58.

Zaitsev A.Y. 2022. Implementation of project and process management in mining enterprises. Technoeconomics. 2 (2). 12–20. DOI: https://doi.org/10.57809/2022.2.2.2

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