UDC 656.7.086 (45)

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STRUCTURAL ANALYSIS OF MANAGEMENT ENVIRONMENT OF AVIATION ENTERPRISE FROM THE POINT OF SYSTEMATIC APPROACH

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Abstract. *The article represents the results of structural analysis of management environment of aviation enterprise. As follows from the analysis, inhomogeneous factors which influence on the aviation activity were classified and formalized. Inhomogeneous factors of internal and external management environment of aviation enterprise were systematically generalized using set-theoretical approach. The influence of factors of internal and external management environment on the aviation enterprise's aviation activity was determined.*

Keywords: aviation enterprise; expert estimation; factors decomposition; management environment; set-theoretical approach; weight coefficients.

1. Introduction

It is considered that aviation is the most fail-safe type of transfer. In as little as century, aviation, in the sphere of flight safety, rose through the ranks from unstable system to the first «ultra safe» system in the history of transport, it means system in which the number of catastrophic failures, in the sphere of safety, make up less than one per one million of production cycles [1].

According to ICAO's data [2], comparing with 2011, in 2012 the number of incidents in the world decreased on 21 %, in 2013 – on 13 %; number of fatalities in 2012 decreased on 10 %, in 2013 – on 55 %. Consequently, the least number of deaths was fixed in 2012-2013, starting from 2004. As a result of decreased number of incidents, and increased number of departures, the frequency of incidents in the world in 2012 was reduced to 3,2 events per million departures and in 2013 – to 2,8 events per million departures. This is the lowest value since the ICAO started to monitor the frequency of incidents in the world.

Aviation systems cannot be wholly free from dangerous factors and connected with them risks, while, the elimination of aviation events and serious incidents continues to be the final goal of human activity in the sphere of aviation safety. Neither human activity nor systems created by it guarantee a total absence of operating errors and their consequence [3].

In such a way, safety is a dynamic characteristic of aviation with the help of which risk factors for flight safety should steadily decrease. It is important to note that adoption of efficiency indices of ensuring flight safety is frequently influenced by internal and international standards and also by cultural features [4]. While risk factors for flight safety and operating errors are under control, such opened and dynamic system as civil aviation may be controlled providing the necessary balance between flight performance and safety requirements for passengers and their baggage [3].

ICAO constantly develops and improves proactive, based on the risks evaluation, methods, directed on the farther decrease in number of aviation events in the world. Also ICAO encourages aviation communities to recognize the importance of adherence of the single global approach for safety improvement and monitoring [2]. A modern approach, founded on the characteristics (performance-based approach – PBA) [5], based on the next three principles: the main accent on desired/necessary results; decision making, oriented on desired/necessary results; using facts and data while decision making.

Herein the principle "using facts and data while decision making" admits that tasks shall comply with the widely known in Western management

criteria SMART [5], that correspond to abbreviation of five English words: specific, measurable, achievable, relevant and timebound.

Such level of accuracy of tasks determination may be achieved only using the way of consistent and structural description of inhomogeneous components of aviation – aviation enterprises, aviation personnel, aviation infrastructure, techniques, rules and information that is used for creating of conditions and applying of aerospace by aircraft users [6; 7].

2. Analysis of research and publication

Nowadays a new approach for flight safety provision is forming in global practice. The ICAO's term «Safety Management System» (SMS) [3] integrates operations and technical systems with the management of financial and human resources to ensure aviation safety or the safety of the public.

Given statement implies binding into one, in a single system different objects and subjects of aviation activity. The subjects of aviation activity are designers and manufacturers of aviation equipment, airline operators, organizations engaged in aircraft maintenance and repair, and also handling companies. The air traffic services providers, aviation educational institutions, research and design aviation organizations, aviation authorities are included to them. Each of subject of aviation activity is used to provide manufacturing processes and functioning of civil aviation the appropriate objects: aircrafts, their components and equipment, industrial equipment, ground vehicles, aerodrome and on-route equipment (radio- and electrotechnical facilities), engineering technical buildings, other movable and immovable assets, ect. And it is a very complex task to join the named elements of aviation.

Since the period of «organizational era» (1990s – present) flight safety has been considered systematically, taking into account organizational, human and technical factors. Also at that date, a notion «aviation incident because of organizational reasons» appeared in aviation, taking into account impact of organizational culture and politics on the control systems efficiency for flight safety risk factors. The «Swiss Cheese Model» by James T. Reason shows that significant role in the incidents causation belongs to organizational and management factors [3].

Building an effective safety management system of aviation activity requires an integrated research of environment in which aviation enterprises operate. The structure of the enterprise environment is considered in depth in the works of such prominent scholars in the field of management M. Mescon, M. Albert and F. Khedouri [8]. Many research related to the determination of influence of factors of internal and external management environment of aviation enterprise on the efficiency of its business [9]. Estimating of the level of influence of factors of aviation enterprise's management environment on the efficiency of Safety Management System is a perspective task.

3. Aims of the work

1. To investigate the structure of management environment of aviation enterprise.
2. To carry out decomposition of internal and external management environment of aviation enterprise.
3. To generalize inhomogeneous factors of internal and external management environment of aviation enterprise with the help of set-theoretical approach.
4. To determine the influence of factors of internal and external management environment of aviation enterprise on aviation activity

4. The structure of internal and external management environment of aviation enterprise

Safety management of aviation enterprise is directed on the formation and provision the achieving its goals rationally using present resources (labour, material, financial, informational, etc) [3; 8].

Aviation enterprise is under continuous pressure from different branches of internal and external environment [8]. Aviation enterprise's management environment is a set of circumstances and factors inside and around that affect decision making process [8] (fig. 1).

Internal environment of aviation enterprise is a complex of components connected with each other by means of certain structures within it. The main variables of internal environment of aviation enterprise management:

– enterprise goals – specific final state or desired result, which must be achieved (safety, regularity and economic efficiency of aviation activity; while in the context of aviation, achievement of safety means to achieve state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level [3]);

– enterprise tasks – predictable work, series of works or part of it, which must be done with the help of previously defined method at predetermined time (detection of negative factors that influence on safety, regularity and economic efficiency of aviation activity; management of risk factors);
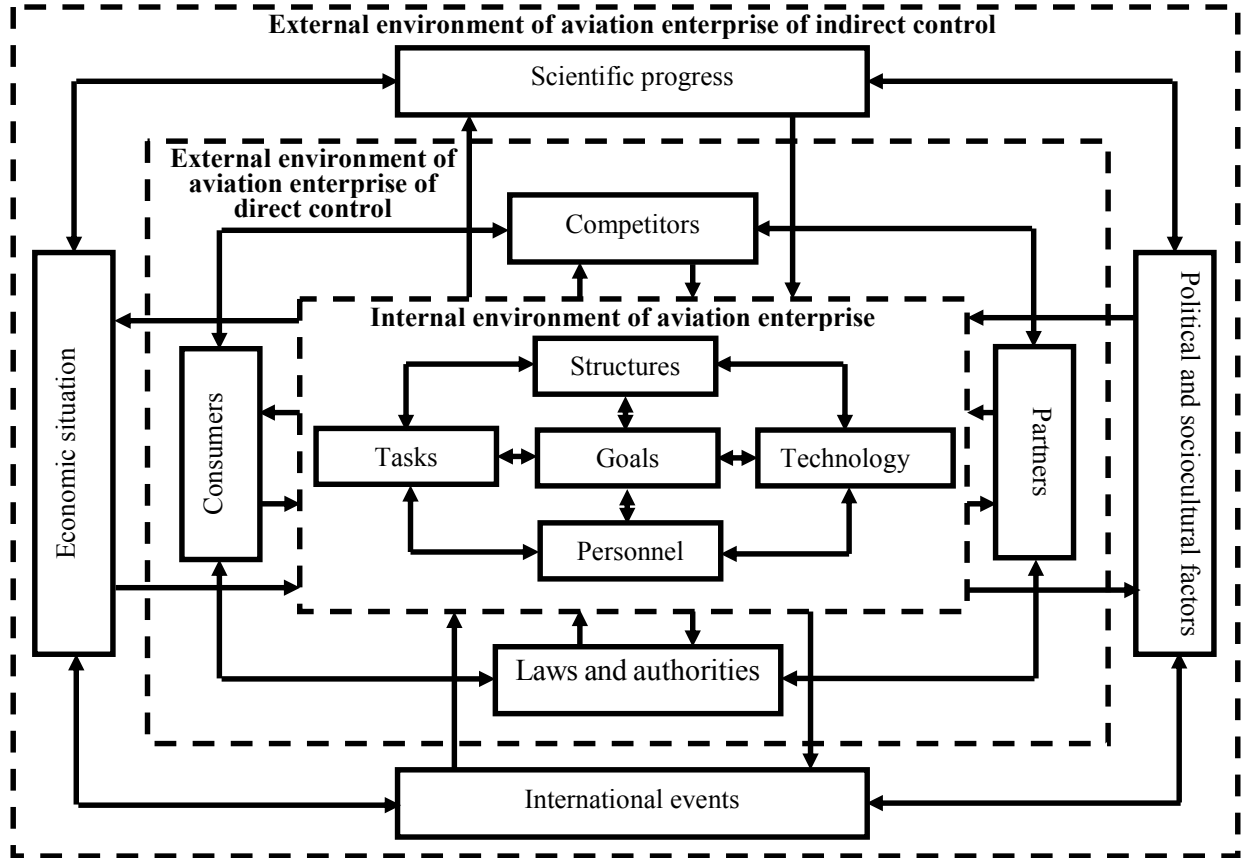
Fig. 1. Environment of the aviation enterprise's management

– aviation enterprise structures – logical relationships, the interaction of organizational forms of technical processes, inputs processing, constructed in such a way that it is possible to achieve the goals of aviation enterprise in the most effectively way (functional interaction diagrams);

– technologies – conversion process in the system, which consists of programs testing and implementation of operations over resources in order to transform them into the desired product (established sequence of operational development, production and sale of air, aeronavigation, airport, maintenance, handling, ect. services);

– people of aviation enterprise (central factor) – aviation personnel with their abilities, aptitudes, needs, expectations, perceptions, attitude and values (crew members, personnel of technical maintenance, etc).

Internal variables as usual are called sociotechnical subsystems because they have social component (people) and technical components (other internal variables).

External environment of aviation enterprise management is a complex of elements which are not part of aviation enterprise but have some influence

on it. The main characteristics of external environment of aviation enterprise are relation of its factors, complexity, mobility and uncertainty. External environment of aviation enterprise management is divided into two types:

a) external environment of direct influence – is an environment that includes elements that directly affect the operations of aviation enterprise and feel the direct impact of its operations. They are:

– consumers of air (passengers, corporate clients, VIP-clients, etc) and other services in aviation – natural or legal persons who use services for personal needs or for needs of their organization;

– competitors – producers of similar air, aeronavigation, airport, maintenance, handling, ect. services on the market;

– partners – legal or natural persons who are co-owners of the aviation enterprise or temporary partners according to any transaction, agreement (air navigation service providers, airports, handling and cleaning companies, catering firms, hotels, etc.);

– laws and authorities – legal and normative acts of bodies of higher legislative and executive powers or their special bodies that oversee the compliance with state requirements (international and local regulations,

applicable regulations of the former USSR Ministry of Civil Aviation);

b) external environment of indirect influence – is a complex of factors that do not influence directly, don't an immediate impact on the operations of aviation enterprise, but will eventually be shown to them. They are:

– economic situation – tendency and level of inflation, interest rate, level of unemployment;

– progress in science and technology – correspondence between techniques and present requirements/standards;

– political factors – tendency in the sphere of legislation, court cases, etc.;

– sociocultural factors - set of attitudes, values, norms, beliefs, and behavior, etc;

– international events – the processes which take place outside the country and influence on the central rate, business struggle, etc.

Any aviation enterprise is operating in the environment and functioning in the case when the environment gives it that opportunity. There should be an idea as of internal so of external environment in order to determine the level of safety of certain aviation enterprise, its potential and development trend and also its place in the environment. The study of the internal and external environment allows aviation enterprise to reduce the negative impact of the elements on the level of safety, and increase opportunities to improve safety.

5. Factors decomposition of management environment of aviation enterprise

Decomposition of factors which influence on safety was done in order to provide structural analysis of management environment of aviation enterprise (fig. 2).
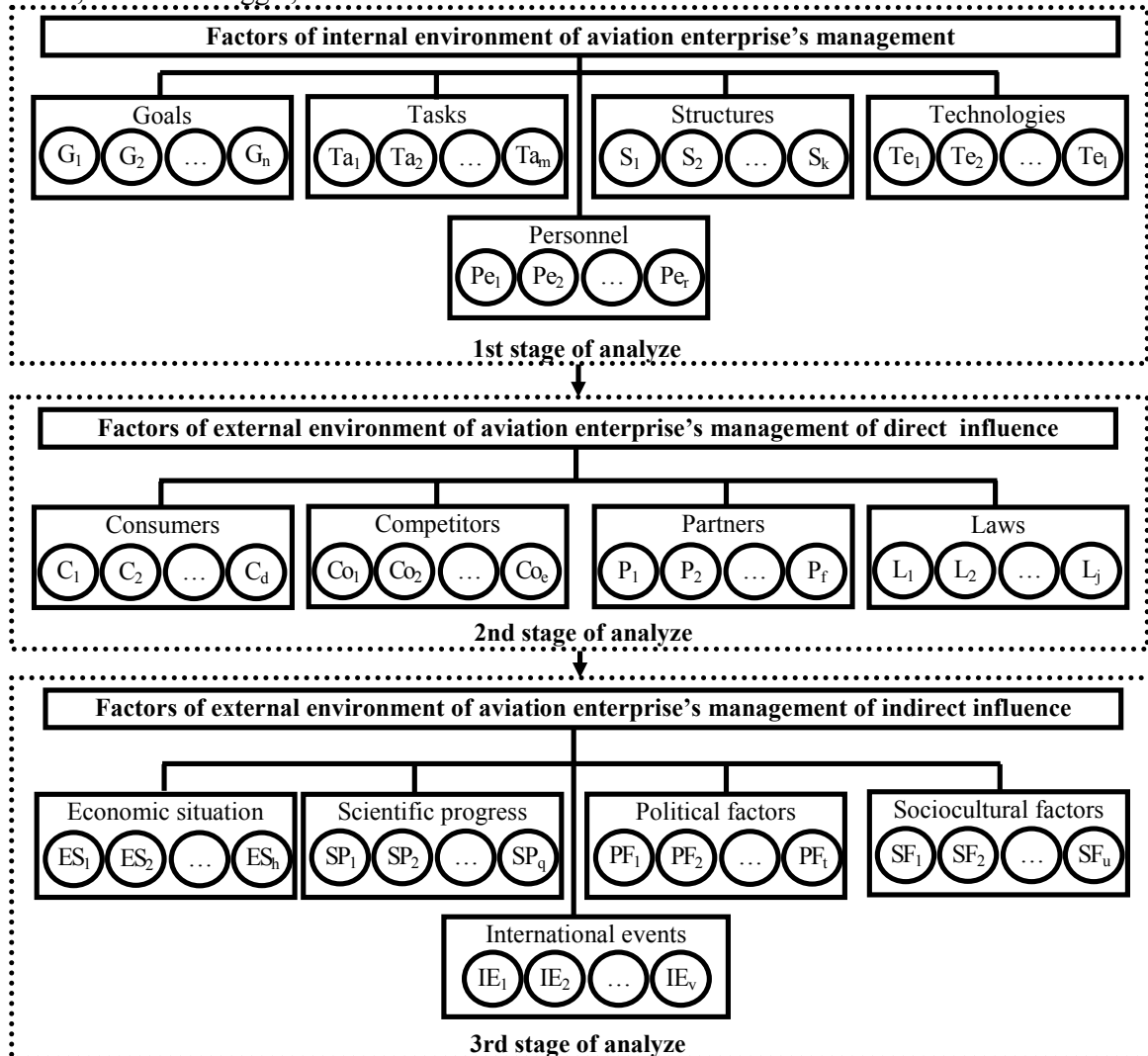

Fig. 2. Decomposition of factors of environment of the aviation enterprise's management

Content and formal description of parameters is given in tables 1–3. The structural analysis of management environment of aviation enterprise was carried out in order of significance decreasing of its factors: firstly, the factors of internal management environment were analyzed, secondly – factors of external management environment of direct influence and, ultimately, factors of external management environment of indirect influence.

In such a way, from the point of systematic approach the factors of internal and external management environment of aviation enterprise which influence on its aviation activity were determined.

Table 1. Decomposition of factors of internal management environment of aviation enterprise $\overline{F}_{ie}$

№	Factors	Parameters	Coding
1	Goals $\overline{G} = \{G_1, G_2, ..., G_n\}$	Safety of aviation activity	G_1
2		Regularity of aviation activity	G_2
3		Economic efficiency of aviation activity	G_3
4	Tasks $\overline{Ta} = \{Ta_1, Ta_2, ..., Ta_m\}$	Conservation of human life and health	Ta_1
5		Protection from acts of unlawful interference	Ta_2
6		Environmental control	Ta_3
7		Effective resource exploitation	Ta_4
8		Protection from informative hazards	Ta_5
9		Prevention of failures in work	Ta_6
10		Profit earning	Ta_7
11		Quality aviation services production	Ta_8
12	Structures $\overline{S} = \{S_1, S_2, ..., S_k\}$	Linear structure	S_1
13		Functional structure	S_2
14		Divisional structure	S_3
15		Design structure	S_4
16		Matrix structure	S_5
17		Process structure	S_6
18	Technologies $\overline{Te} = \{Te_1, Te_2, ..., Te_l\}$	Aircraft performance characteristics	Te_1
19		The level of aircraft dilapidation	Te_2
20		The level of special techniques dilapidation	Te_3
21		The level of buildings and constructions dilapidation	Te_4
22		Technological operations on development of aviation services	Te_5
23		Technological operations on realization of aviation services	Te_6
24		Technological operations on ground servicing	Te_7
25		Technological operations on maintenance	Te_8
26		Technological operations on airport servicing	Te_9
27		Technological operations on aeronavigation servicing	Te_{10}
28	Aviation personnel $\overline{Pe} = \{Pe_1, Pe_2, ..., Pe_r\}$	Flight crew and passenger cabin crew	Pe_1
29		Commanders, inspectors and instructors	Pe_2
30		Experts who are carrying out the regulation of airspace usage and air traffic service	Pe_3
31		Experts who are carrying out organization and maintenance of the aircraft and other types of flight servicing	Pe_4
32		Experts of air traffic service	Pe_5
33		Experts who carrying out organization and performance of design and experimental, experimental, research and development works while flight tests of aviation techniques	Pe_6
34		Experts who are carrying out supervision and control of flights safety and those who perform investigation of aviation events	Pe_7
35		Experts who are carrying out the analysis and control of the flight validity of the aircraft during development, testing, certification and a mass production	Pe_8
36		Experts of aviation safety	Pe_9
37		Aviation experts	Pe_{10}

Table 2. Decomposition of factors of external management environment of aviation enterprise of direct influence $\overline{F}_{eedi}$

№	Factors	Parameters	Coding
1	Consumers $\overline{C} = \{C_1, C_2, ..., C_d\}$	First-class passengers	C_1
2		Business-class passengers	C_2
3		Economy-class passengers	C_3
4		Baggage clientage	C_4
5		Corporate clients	C_5
6		VIP-clients	C_6
7		Customer of aviation works	C_7
8	Competitors $\overline{Co} = \{Co_1, Co_2, ..., Co_e\}$	Airlines – limited liability company	Co_1
9		Airlines – private joint stock company	Co_2
10		Airlines – public joint-stock company	Co_3
11		Airlines – government companies	Co_4
12		Airlines – private companies	Co_5
13		Foreign airlines	Co_6
14	Partners $\overline{Pa} = \{Pa_1, Pa_2, ..., Pa_f\}$	Members of aviation alliance	Pa_1
15		Flights sales agencies	Pa_2
16		Air navigation service providers	Pa_3
17		Airports	Pa_4
18		Handling companies	Pa_5
19		Cleaning companies	Pa_6
20		Fuel servicing companies	Pa_7
21		Catering companies	Pa_8
22		Organization for aircraft maintenance	Pa_9
23		Autotransportation enterprises	Pa_{10}
24		Hotels	Pa_{11}
25	Laws $\overline{L} = \{L_1, L_2, ..., L_j\}$	Constitution of Ukraine	L_1
26		Laws of Ukraine	L_2
27		International agreements of Ukraine	L_3
28		Aviation legislation of Ukraine	L_4
29		International conventions and proceedings	L_5
30		ICAO Standards and Recommended Practices (SARPs)	L_6
31		Joint Aviation Requirements (JAR)	L_7
32		Eurocontrol SAfety Regulatory Requirements (ESARRs)	L_8
33		Resolutions of the Verkhovna Rada of Ukraine	L_9
34		Edicts of the President of Ukraine	L_{10}
35		Resolutions, ordinance of the Cabinet of Ministers of Ukraine	L_{11}
36		State standards of Ukraine	L_{12}
37		Orders of State Aviation Administration of Ukraine	L_{13}
38		Aviation rules of Ukraine	L_{14}
39		Sectoral guidance documents	L_{15}
40		Aviation rules of the former USSR	L_{16}
41		State standards of USSR	L_{17}
42		Sectoral guidance documents (sectoral standards, guidance documents)	L_{18}

Table 3. Decomposition of factors of external management environment of aviation enterprise of indirect influence $\overline{F}_{eeii}$

№	Factors	Parameters	Coding
1	Economic situation $\overline{ES} = \{ES_1, ES_2,..., ES_h\}$	Cost of living	SE$_1$
2		Minimum salary	SE$_2$
3		Minimum pension	SE$_3$
4		Average earnings	SE$_4$
5		Inflation rate	SE$_5$
6		Bank interest rate	SE$_6$
7		Unemployment rate	SE$_7$
8		State of investment activities in transport domain	SE$_8$
9		Development of tourism	SE$_9$
10	Scientific and technical progress $\overline{SP} = \{SP_1, SP_2,..., SP_q\}$	Level of moral depreciation of aircraft	ST$_1$
11		Level of moral depreciation of special techniques	ST$_2$
12		Level of moral depreciation of buildings and constructions	ST$_3$
13		Progressiveness of technological schemes on development and realization of aviation services	ST$_4$
14		Progressiveness of technological schemes from ground, technical, airport, air navigation services	ST$_5$
15	Political factors $\overline{PF} = \{PF_1, PF_2,..., PF_t\}$	Stability of political regime	PF$_1$
16		Level corruption	PF$_2$
17		Crime rate	PF$_3$
18		Level of state regulation in aviation sphere	PF$_4$
19	Sociocultural factors $\overline{SF} = \{SF_1, SF_2,..., SF_u\}$	Social structure of society	SF$_1$
20		National and household traditions of population	SF$_2$
21		Popularity of air traffic	SF$_3$
22	International events $\overline{IE} = \{IE_1, IE_2,..., IE_v\}$	Global economic situation	IE$_1$
23		Strategic-military situation	IE$_2$
24		Influence of certain states	IE$_3$
25		Nature effect	IE$_4$
26		State of raw material and natural resources	IE$_5$

6. Generalization of inhomogeneous factors of internal and external management environment of aviation enterprise

Generalization of inhomogeneous factors of internal and external management environment of aviation enterprise was carried out using set-theoretical approach [10]. This gave possibilities to consider structural hierarchy, heterogeneity, dynamic instability of factors and to define conditions for their assessment:

$$\overline{F} = \overline{F}_{ie} \bigcup \overline{F}_{eedi} \bigcup \overline{F}_{eeii},$$

where $\overline{F}_{ie} = \{\overline{G}, \overline{Ta}, \overline{S}, \overline{Te}, \overline{Pe}\}$ – is set of factors of internal management environment of aviation enterprise (goals $\overline{G}$, tasks $\overline{Ta}$, structures $\overline{S}$, technologies $\overline{Te}$, personnel $\overline{Pe}$);

$\overline{F}_{eedi} = \{\overline{C}, \overline{Co}, \overline{Pa}, \overline{L}\}$ – is set of factors of external management environment of aviation enterprise of direct influence (consumers $\overline{C}$, competitors $\overline{Co}$, partners $\overline{Pa}$, laws and authorities $\overline{L}$);

$\overline{F}_{eeii} = \{\overline{ES}, \overline{SP}, \overline{PF}, \overline{SF}, \overline{IE}\}$ – is set of factors of external management environment of aviation enterprise of indirect influence (economic situation $\overline{ES}$, scientific and technical progress $\overline{SP}$, political factors $\overline{PF}$, sociocultural factors $\overline{SF}$, international events $\overline{IE}$).

Fig. 3 shows graphical interpretation of method of inhomogeneous factors generalization of internal and external management environment using set-theoretical approach.
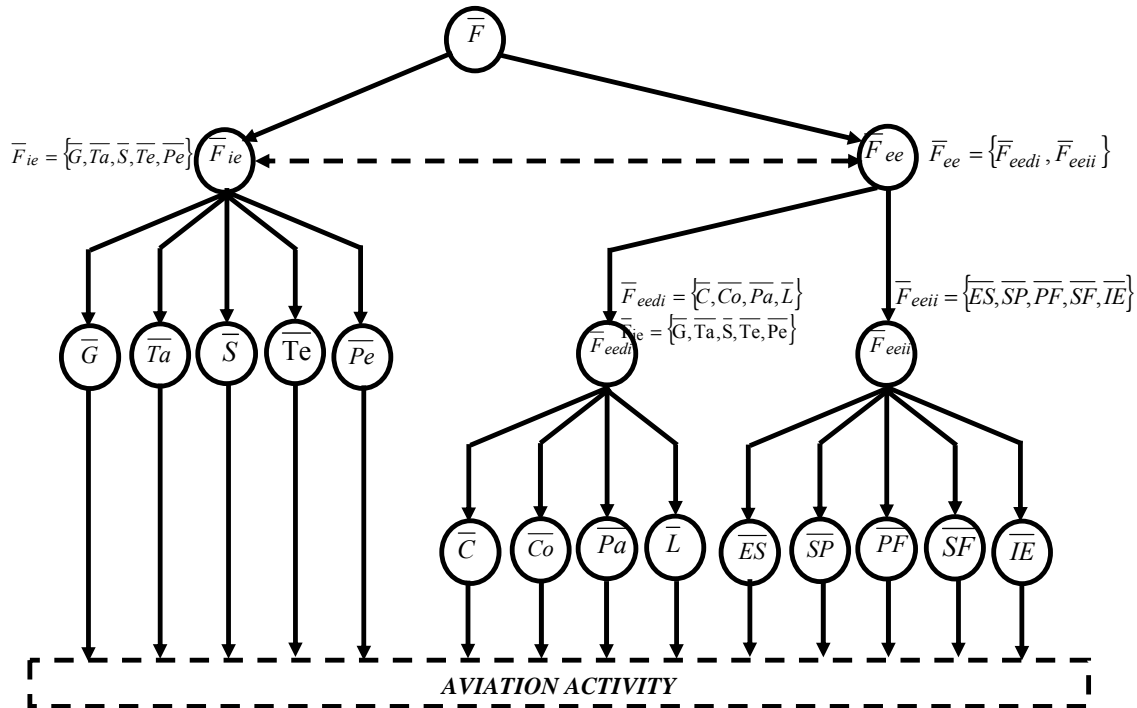
Fig. 3. Graphical interpretation of method of inhomogeneous factors generalization of internal and external management environment of aviation enterprise: $\overline{F}_{ie}$ – set of factors of internal management environment of aviation enterprise; $\overline{F}_{ee}$ – set of factors of external management environment of aviation enterprise; $\overline{F}_{eedi}$ – set of factors of external management environment of direct influence aviation enterprise; $\overline{F}_{eeii}$ – set of factors of external management environment of indirect influence of aviation enterprise; $\overline{G}$ – goals; $\overline{Ta}$ – tasks; $\overline{S}$ – structures; $\overline{Te}$ – technologies; $\overline{Pe}$ – personnel; $\overline{C}$ – consumers; $\overline{Co}$ – competitors; $\overline{Pa}$ – partners; $\overline{L}$ – laws and authorities; $\overline{ES}$ – economic situation; $\overline{SP}$ – scientific and technical progress; $\overline{PF}$ – political factors; $\overline{SF}$ – sociocultural factors; $\overline{IE}$ – international events

7. Influence of factors of internal and external management environment of aviation enterprise on aviation activity

Method of expert estimation was used in order to define the level of influence of factors of internal and external management environment of aviation enterprise on aviation activity.

Respondents from among pilots and air traffic controllers of different age categories, with different professional experience filled in the offered questionnaires and defined individual preferences concerning influence of factors of internal and external management environment of the aviation enterprise on aviation activity.

Priority influence of factors on aviation activity was established by comparison of weight coefficients. As an example, fig. 4-5 show the influence of goals and international events of internal and external management environment correspondingly on aviation activity. There were defined, that the greatest influence has:
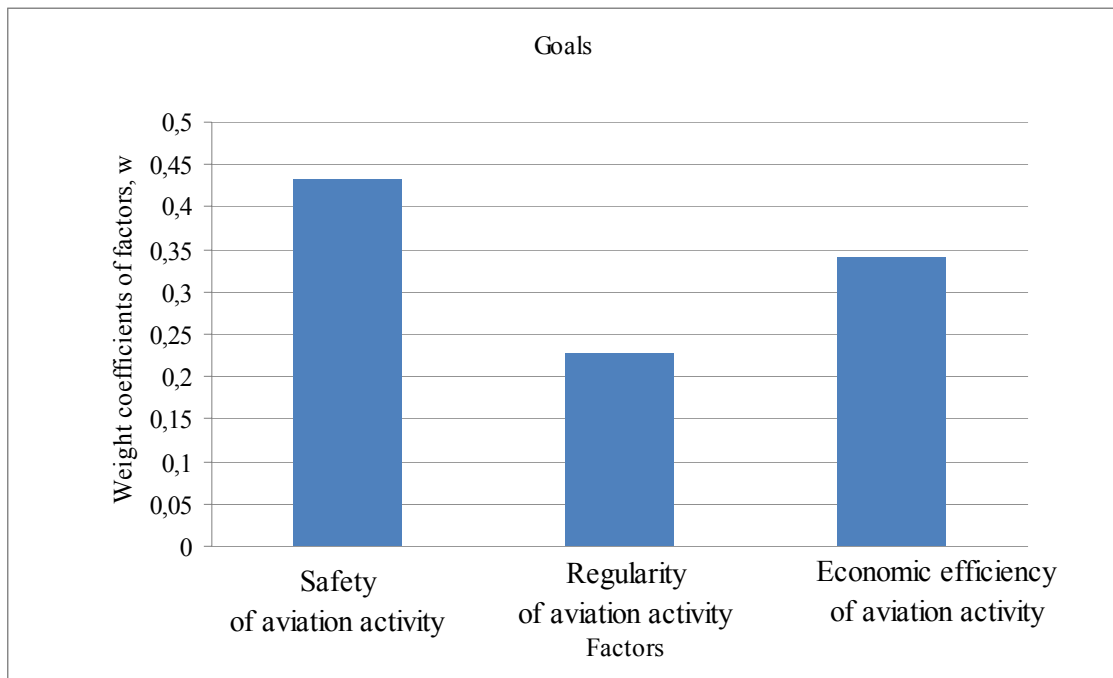
– the level of safety of aviation activity (factor of internal management environment of aviation enterprise);

– global economic situation (factor of external management environment of aviation enterprise).

8. Conclusions

Factors of internal and external management environment of aviation enterprise which influence on aviation activity were determined from the point of systematic approach.

Aviation enterprise is a complex of basic elements such as goals, tasks, structures, technologies, personnel, and also environment – political, economical, cultural, market which interact and to which it has to adapt. Internal environment of aviation enterprise is a source of life force and includes the potential which give possibilities to exist and survive in a defined time period but also it can be a source of problems. External environment

Fig. 4. Influence of factors of internal management environment of aviation enterprise
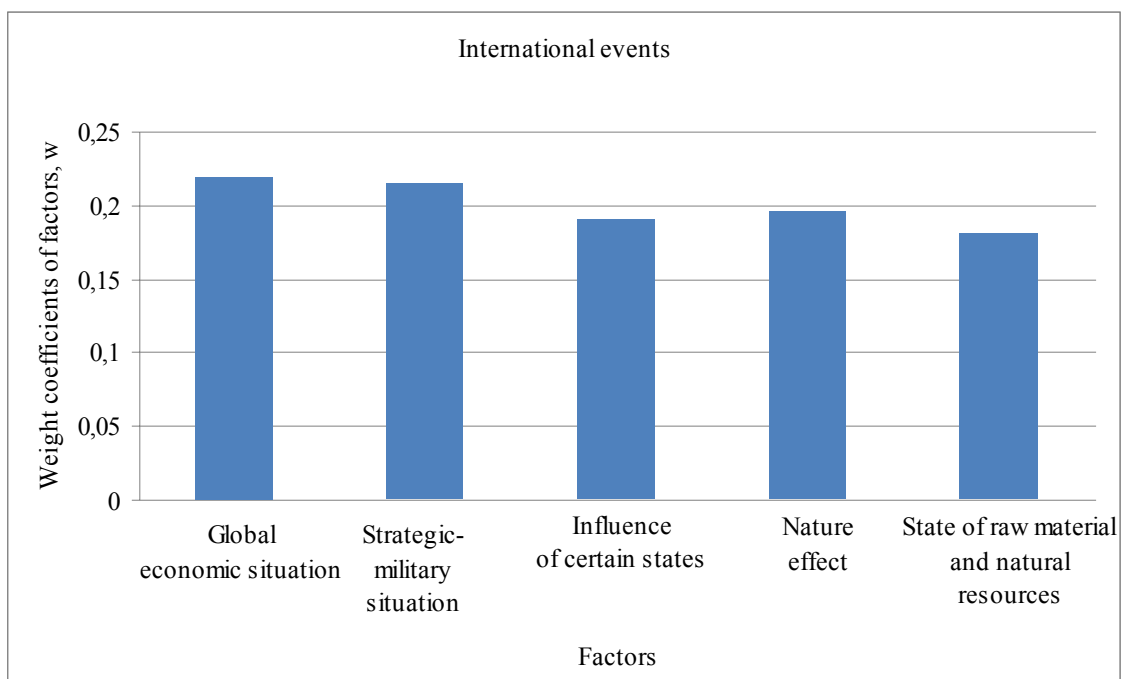
Fig. 5. Influence of factors of external management environment of indirect influence of aviation enterprise

is a source of resources needed for maintenance of its internal potential at the necessary level in order to achieve aviation enterprise's goals.

Inhomogeneous factors of internal and external management environment of aviation enterprise were generalized using set-theoretical approach.

This gave possibilities to define that the level of safety of aviation activity has the greatest influence among factors of internal environment and global economic situation – among factors of external environment.

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Т. Ф. Шмельова[1], Ю. В. Сікірда[2], О. Ю. Ассаул[3], О. С. Стасюк[4]. Структурний аналіз середовища менеджменту авіапідприємства з позицій системного підходу

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Зараз у світовій практиці складається новий підхід до забезпечення безпеки польотів, який полягає у спробі інтеграції в єдину систему різних об'єктів та суб'єктів авіаційної діяльності, що є досить складним завданням. Побудова ефективної системи менеджменту безпеки авіаційної діяльності потребує комплексного дослідження середовища, в якому функціонують авіапідприємства.

Для проведення структурного аналізу середовища менеджменту авіапідприємства виконана декомпозиція факторів, які впливають на безпеку авіаційної діяльності, отримано формалізований опис їхніх параметрів. Визначено, що внутрішнє середовище менеджменту авіапідприємства включає цілі, завдання, структури, технології та людей авіапідприємства; зовнішнє середовище прямого впливу – споживачів авіапослуг, конкурентів, партнерів, закони і державні установи; зовнішнє середовище опосередкованого впливу – стан економіки, науково-технічний прогрес, політичні та соціокультурні фактори, міжнародні події.

За допомогою теоретико-множинного підходу системно узагальнено неоднорідні фактори внутрішнього та зовнішнього середовища менеджменту авіапідприємства, що дозволило врахувати структурну ієрархічність, різнорідність, динамічну нестабільність факторів та визначити умови для їх оцінювання.

Методом експертних оцінок визначено ступінь впливу факторів внутрішнього та зовнішнього середовища менеджменту авіапідприємства на авіаційну діяльність. Встановлено, що з факторів внутрішнього середовища на авіапідприємство найбільший вплив має рівень безпеки авіаційної діяльності, із зовнішніх факторів – стан світової економіки.

Ключові слова: авіаційне підприємство; вагові коефіцієнти; декомпозиція факторів; експертні оцінки; середовище менеджменту; теоретико-множинний підхід.

Т. Ф. Шмелева[1], Ю. В. Сикирда[2], А. Ю. Ассаул[3], О. С. Стасюк[4]. Структурный анализ среды менеджмента авиапредприятия с позиций системного подхода

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В данное время в мировой практике складывается новый подход к обеспечению безопасности полетов, который заключается в попытке интеграции в единую систему разных объектов и субъектов авиационной деятельности, что является довольно сложной задачей. Построение эффективной системы менеджмента безопасности авиационной деятельности требует комплексного исследования среды, в которой функционируют авиапредприятия.

Для проведения структурного анализа среды менеджмента авиапредприятия выполнена декомпозиция факторов, которые влияют на безопасность авиационной деятельности, получено формализованное описание их параметров. Определено, что внутренняя среда менеджмента авиапредприятия включает цели, задачи, структуры, технологии и людей авиапредприятия; внешняя среда прямого влияния – потребителей авиауслуг, конкурентов, партнеров, законы и государственные учреждения; внешняя среда косвенного влияния – состояние экономики, научно-технический прогресс, политические и социокультурные факторы, международные события.

С помощью теоретико-множественного подхода системно обобщены неоднородные факторы внутренней и внешней среды менеджмента авиапредприятия, что позволило учесть структурную иерархичность, разнородность, динамическую нестабильность факторов и определить условия для их оценивания.

Методом экспертных оценок определена степень влияния факторов внутренней и внешней среды менеджмента авиапредприятия на авиационную деятельность. Установлено, что из факторов внутренней среды на авиапредприятие наибольшее влияние оказывает уровень безопасности авиационной деятельности, из внешних факторов – состояние мировой экономики.

Ключевые слова: авиационное предприятие; весовые коэффициенты; декомпозиция факторов; среда менеджмента; теоретико-множественный подход; экспертные оценки.

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