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Table of Contents

Trends in Digital Governance in the Field of Space Activities

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The relevance of this article is based on the need to find an answer to the question: are there mechanisms in the legal field and at the level of the management concept for adaptation to the inevitable evolutionary processes of the space industry, or is it necessary to look for new ways to regulate space activities? To answer this question, the authors needed to study the scientific doctrine, international acts and individual national norms of Ukraine regarding the identification of prerequisites for the development of global and national digital governance in the field of space activities, as well as the prospects for its proper functioning. The research is based on the use of a set of methods and techniques for carrying out scientific research. The main ones among which were the methods of analysis and synthesis, the formal-legal and the method of formalization. As a result of the study, it was stated that legal regulation does not keep pace with the development of the space industry and does not have the ability to cover all modern aspects of space activity with its influence. This leads to the need for a transition from formal bureaucracy to digital democracy in the aspects of legal regulation of space legal relations at the global and national levels. The example of Ukraine demonstrates the potential for the transition to this model of organizing and implementing communication between the authorities and society in the space industry, but it also indicates the need for a number of important administrative reforms.

Keywords: digital governance, global administrator, outer space, space activities, space legal relations.

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Introduction

The world is transforming today. And this statement can be understood in different ways. On the one hand, we are talking about the presence of pinpoint global problems, the solution of which world players are throwing all possible forces. For example, the ecological, which already have catastrophic consequences and the struggle with which has been going on for decades. So it is with the newly formed ones, for example, outbreaks of pandemics, the solution of which must be quick and accurate. There are also global problems that can hardly be called pinpoint. This is because their presence entails the gradual destruction of a significant range of world interests. For example, the lack of proper regulation of space activities, including the use of artificial intelligence or registration of space objects, can lead to unresolved legal liability issues. And in the future, these questions will only get worse.

On the other hand, it should be taken into account that any development involves a transition from one state to another. The world will not be the same as it was decades ago. We are actively introducing into everyday life such things that were not available a few years ago. And we are talking not only about scientific technologies, most of which are already available to almost everyone. We are talking about inevitable processes that have already become the norm.

All over the world, the use of space technologies for everyday purposes has become the norm. Commercial use of outer space will soon become the norm. Moreover, there are all the prerequisites for this. First, competition in world markets is intensifying both in the development of spacecraft and delivery systems and in the development of advanced science-intensive services (Danilin, 2018: 167). Secondly, the informatization and digitalization of the world economy entail an expansion of the market for space data – both in high-tech and traditional (agricultural sector, transportation and retail, healthcare, etc.) (Danilin, 2018: 167). These processes are changing the dynamics and nature of the evolution of the space industry and markets and pose serious challenges for space policy (Danilin, 2018: 168).

The main question is whether there are mechanisms for such adaptation in the legal field and at the level of the management concept, or is it necessary to look for new ways to resolve issues related to the inevitable evolutionary process of the space industry?

It is noteworthy that today the evolution of the space economy and digital technologies is leading to reformatting of space policy: the diversification of actors and functions, the formation of new clusters, the development of ecosystems, partly crowding out, partly organically complementing existing structures (Danilin, 2018: 176). Accordingly, does legal regulation keep pace with these developments? Does it have the ability to cover all these issues with its influence?

Obviously not. This is confirmed by the emergence of a new model of industrial and technological policy in the space sector (Danilin, 2018: 176). It presupposes a reassessment of the role of the state as an equal participant in space activities along with private space players and a more active organizer of the digitalization of society, taking into account changes in its specifics.

It should be understood that the prospects for space policy are primarily associated with the development of scientific and technological cooperation. Therefore, we can say with confidence that the use of digital technologies both in the mechanism of global and public administration and in certain regulated industries, such as, for example, space activities, is inevitable.

In fact, some authors consider the use of digital technologies to reform government structures, politics and public administration to be a "panacea" for the twenty-first century. They are presenting it as "an enlightened way to revive democracy and improve the quality of services for citizens" (Milakovich, 2011). Others, examining the impact of digitalization on our lives, point to the underlying financial challenges of many businesses, governments and other organizations at the heart of the e-government revolution (Milakovich, 2011). However, all agree that digital technologies, artificial intelligence, products and services of space activities affect the management sector around the world and its services.

Therefore, many governments are moving from a technology-oriented approach to a more citizen-oriented approach when providing online services (Milakovich, 2011).

Also, no one denies that with the help of digitalization tools, many manual processes have already been automated, which has improved the quality of service. And these are just a few of them: online filing of documents, online payments for various accounts, taxes, online registration of assets owned by individuals and commercial organizations, etc., which allows governments to operate smoothly and efficiently in the interests of public welfare (Khan et al., 2020; Almeida et al., 2020).

In the current realities, the issue of the relationship between global digital governance and national digital governance in the field of space activities is quite relevant.

In our opinion, global and national digital governance should be understood as management, which is characterized by digital democracy integrated into the mechanisms of public administration. The difference is at what level decisions are made.

Regarding the development of space policy in the context of global digitalization of state mechanisms of influence on legal relations, it should be noted that it is too early to talk about building a global digital structure for managing space activities. This is because not all states have national space regulatory legal acts that regulate the order, methods, methods and legal regimes in the field of space activities. And those that have – are not brought to a single model. That is, at the present time, it is problematic to ensure the transition to a new management paradigm, referred to as digital governance, at the global level. On the one hand, this requires a more thorough theoretical development of the methodological plane. On the other hand, there is the existence of legal norms that ensure such a transition.

So, for the focused question, we need to focus on the example of a specific country. It was decided to explore the experience of Ukraine. We need to consider the features of the process of transition from formal bureaucracy to digital democracy since the area under study is characterized by nonlinearity in managerial decision-making. Below we will give examples of how the digital governance of Ukraine is being implemented today in the field of space activities. Based on the data received, we will be able to see if Ukraine is ready for the transition to a new paradigm of space legal relations management.

Ukraine's transition from formal bureaucracy to digital democracy

We have the opportunity to observe that formal bureaucracy is beginning to lose its relevance in the world. Indeed, it has already become clear that the administrative system may gradually abandon the hierarchical descent of power vertically to function effectively, also, from the burden of certain procedures for making socially important decisions, with the transition to partnerships.

In the context of globalization pressures that have intensified since the 1970s, governments in both industrialized and less developed countries have had to undertake large-scale administrative reforms and reorganizations to streamline their public sectors by reducing their size, functions, and activities. Hence the shift of the neoliberal paradigm with the accompanying aspect of "New Public Management" (NPM) (Farazmand, 2002). The main features of this theory are the focus on the rational use of budget funds, revision and transfer on a contractual basis of public services to private enterprises and increase their responsibility for the quality of these services, decentralization of budgetary and government powers (Solovyov, 2014: 83).

At the same time, it should be understood that the New Public Management approach does not eliminate bureaucracy, but only modifies it, which, according to Edwin Olson and Eoyang Eoyang, has led to so-called "professional bureaucracy" or "amateur bureaucracy" – without leadership and knowledge or technical capabilities, solving complex social issues (Olson & Eoyang, 2003; Keys, 2013).

Today, the New Public Management approach is far from exhaustive, as many countries have realized the flaws of clean market ideology and private sector efficiency models emphasized by the NPM (Farazmand, 2002). More and more attention is paid to the so-called "turquoise models" of relationships. This is the next level of development of consciousness, when standard concepts and approaches are challenged, and the organization begins to be perceived as a living organism, not a machine (Bass, 2018). Many such models have been described in the literature, including good governance (Leftwich, 1994; Weiss, 2000), partnership, cooperation and connections (Ansell & Gash, 2008; Stoker, 1998) and modern management (Magnette, 2003). Each model offers a slightly different emphasis, which makes the models more or less suitable depending on the local context (Ikeanyibe, 2017).

It should be noted that today in the context of global digitalization, new phenomena have emerged, such as digital governance and digital democracy. These models include a shift from a bureaucratic orientation to a customer-oriented service activity (Milakovich, 2011). Where digital technologies are seen as a means of restoring public trust and improving the quality of services. Also, digitalization contributes to: 1) stimulating wider participation of citizens in the political life of the country; 2) a more efficient and accountable electoral process (conducting electronic polls and referendums, conducting online discussions, forming a public opinion) (van Dijk, 2013); 3) transparency of government activities; 4) active two-way communication and interaction between stakeholders through forums and platforms; 5) public control over the activities of all subjects of government bodies.

However, the question of whether this technological revolution is effectively used by citizens to change political processes remains open, and there is no simple answer to it "yes" or "no" (Milakovich, 2011).

Looking ahead, it should be pointed out that an active, conscious civil society is needed to successfully build digital democracy in Ukraine. It is also necessary to make a transition from public administration, even digital, to digital public administration. However, there is a problem in understanding the categories of "management" and "public administration" at the present stage.

What has always been called public administration abroad has been public administration in Ukraine and is only now beginning to adapt to world standards. However, this thesis can be criticized, in particular, because the country focused on the legislation of the Russian Federation for a long time. In this country, the category of "public administration" is still used

as an analogy of the term "public administration." Therefore, it is possible that in the initial translation of the category of "public administration," domestic representatives of legal and scientific doctrine focused on the terminological apparatus of the neighbouring state. In any case, today, we have the problem of having three related categories – "public administration," "public administration" and "public administration" (Danylenko, 2020: 34).

In our opinion, in Ukraine, the categories of public administration and public administration as part of the mechanism of ordering state and public affairs have become one piece of rubble as self-sufficient. These are interconnected elements of centralized unity that coexist organically. After all, the same social relations can be the subject of public administration and public administration. What does this mean? First of all, depending on the nature of the issue that needs to be resolved, the authorized entities choose its type: in the case of the organization of the public sector – there is public administration, and in the case of private and public interests – public administration (Danylenko, 2020: 34).

Thus, the modern paradigm of public administration in Ukraine is represented by a specific model of its implementation. This type of activity, which represents the performance of state functions, is the social orientation of public authority and involves variability of behavior or organizational structure of the object of administration, which is carried out by providing, protecting, protecting a range of social relations, both individual and public interest and demand from the state support, settlement in the course of their dynamic development.

Solve the question of convergence of the terminological apparatus of the administrative field of knowledge to the applied European common enough easily. In our opinion, we need to move to the model of digital governance – governance, which is characterized by digital democracy integrated into the mechanisms of public administration.

Thus, with the adoption of the Strategy for the Development of the Information Society in Ukraine, the legal category of "electronic democracy" was enshrined in law. It is defined as a form of public relations in which citizens and organizations are involved in state-building and public administration, as well as in local self-government through the widespread use of information and communication technologies (On approval, 2013).

However, since then, the state of development of the information society in Ukraine is still unsatisfactory. From the point of view of the problem of normative-legal, organizational-technical, personnel uncertainty of e-democracy in Ukraine, several alternatives of its decision are considered (Pantsyr & Kohut, 2015). These include a strategy of moderate change and small steps, a centralized strategic approach and a mixed top-down and bottom-up strategy (Pantsyr & Kohut, 2015).

Thus, in order to ensure the transition from bureaucratic public administration to digital public administration, a number of important administrative reforms need to be carried out. As a result, the main goal for public administration bodies, at all levels, will be to reduce public spending, which meets the expectations of citizens and the achievement of the goals of economic growth (Milakovich, 2011; Dijk, 2013), as well as set a benchmark for a conscious civil society and not on the government and public authorities.

Thus, in the new conditions of social development, which is accompanied by comprehensive informatization, deep social transformations and globalization, we should rely on new models of organization and communication of government and society. In Ukraine, there are significant prospects in terms of the implementation of digital democracy, some embryos of which already take place in law-making and law enforcement activities of public administration. Although with some problematic aspects, public services are provided online in the form of functioning

service platforms. In addition, in 2022, it is planned to launch a single national platform for interaction between executive bodies and citizens and civil society institutions (Press, 2021).

Digital governance of space activities in Ukraine

As we have already noted, space information technologies and services have already become an integral part of digital governance. In Ukraine, they are just beginning their path to development in many spheres of the life of society, the state, and, as a result, in law.

On the issue of digitalization of the sphere of space activity, Ukraine does not have many positive examples of the implementation of digital governance. Mainly due to insufficient funding of this industry. Still, she seeks to follow the example of world leaders.

This is because observation from space and space monitoring provides a comprehensive solution to the problems of environmental protection and rational use of natural resources. In addition to purely technical achievements, the organizational experience accumulated in space activities in solving large-scale problems of a complex nature turns out to be very useful (Leskov, 1995: 143). Such experience is cooperation in the creation of intergovernmental information systems for the exchange of data on various issues related to space activities.

For example, during the visit of the President of Ukraine Volodymyr Zelensky to the United States, the State Space Agency of Ukraine (SCA) and the US Space Command (USSPACECOM) signed a Memorandum between the SCA and the US Department of Defense on cooperation in space safety and space services. The document regulates the exchange of information in order to resolve abnormal situations that may arise with spacecraft during their launch into orbit, the ascent from orbit, entry into the atmosphere, disposal, to study electromagnetic interference, etc. (State, 2021).

It should be noted that such a procedure as registration of space objects is also gradually moving into the online format.

In accordance with Part 1, Article II of the Convention on Registration of Objects Launched into Outer Space, which was adopted by the General Assembly in its resolution 3235 (XXIX) on November 12, 1974 (Convention, 1974), registration takes place at the national and international level in two stages. First, the launching state registers the space object by recording in the appropriate register, which it creates and maintains. Thereafter, each launching state informs the Secretary-General of the United Nations of the establishment of such a register. The content of which and the conditions for its conduct are determined by the national state.

The UN registry is administered by the UN Office for Outer Space Affairs (UNOOSA), which created a searchable database as an open-source of information on space objects around the world (Schmidt-Tedd & Soucek, 2020). The main purpose of registration is to fix the legal relationship between the spacecraft (object) launched into space and the launching state and in the register of which this spacecraft (object) is entered to retain jurisdiction and control of this state over such a spacecraft (object), ensuring the possibility of returning the spacecraft (object) to the owner. At the same time, registration is important to establish which state will be responsible for specific space activities and possible liability for damage caused by such spacecraft (object) (Vidyuk, 2020).

UN has developed a platform – an online index of objects launched into outer space (Online, 2021), which provides a fast and efficient means of access to information on space objects provided by states and organizations (United, 2020).

However, there are no normative legal acts that would regulate the creation and vision of the state register of comic objects in Ukraine.

Therefore, today the subjects of space activity of Ukraine face a number of problems caused by the lack of a clear mechanism for regulating space activities. In accordance with Part 1 of Art. 13 of the Law of Ukraine "On Space Activities" spacecraft, such as artificial satellites, automatic interplanetary stations, automatic or manned spacecraft, orbital stations, spacecraft, etc., are subject to mandatory state registration in the State Register of Spacecraft Of Ukraine in accordance with the Rules of registration of spacecraft in Ukraine, approved by the Cabinet of Ministers of Ukraine (Vidyuk, 2020).

The Law of Ukraine "On Space Activities" was adopted in 1996, but so far, no relevant Rules have been developed, and as a result, it has not been determined who exactly, for what period, in what form submits information about the spacecraft to the SCA, which, in fact, should register the spacecraft and maintain the State Register of Spacecraft of Ukraine, how the SCA should inform the Ministry of Foreign Affairs and the UN about the state registration of the spacecraft, etc. In pursuance of Art. 13 of the above the law, as well as the Convention on the Registration of Objects Launched into Outer Space of 14 January 1975 (entered into force for Ukraine on 14 September 1977), the State Space Agency of Ukraine has developed a draft resolution of the Cabinet of Ministers of Ukraine "On approval of the Rules of registration of spacecraft of Ukraine" (Vidyuk, 2020).

Without these rules, there is virtually no official mechanism for registration of spacecraft, which must meet international standards for registration of space objects, the Law of Ukraine "On Space Activities" and the Law of Ukraine "On Administrative Services," because the registration of spacecraft is an administrative service, which is provided to the subject of space activity in case of application to the State Space Agency of Ukraine.

Thus, the preparation of the draft resolution of the Cabinet of Ministers of Ukraine "On approval of the Rules of registration of spacecraft of Ukraine" is an important step towards harmonization of national space law to the legislation of leading space countries in terms of creating legal conditions for registration of spacecraft of Ukraine. In addition to creating legal conditions in this area, the approval in the near future of the Rules of registration of spacecraft of Ukraine will be a significant contribution to the program of digital governance of space activities.

Conclusions

1. The transformation of the world's foundations is the norm today. Along with environmental, geopolitical, medical and other politics, space also has to adapt to new evolutionary realities. Currently, there are no mechanisms for such adaptation in the legal field and at the level of the management concept. Therefore, it is necessary to look for new ways of resolving issues related to the inevitable evolutionary process of all social and legal conditions. Digital management today is one of the most promising models for organizing and implementing communication between government and society. This is due to the fact that the use of digital technologies both in the mechanism of global and state governance and in certain regulated industries, such as, for example, space activities, is inevitable. Accordingly, the issue of global digital governance and its relationship with national digital governance needs further research.

2. Global and national digital governance is governance characterized by digital democracy integrated into public administration mechanisms. Regarding the development of space policy in the context of global digitalization of state mechanisms of influence on legal relations, it should be noted that it is too early to talk about building a global digital structure for managing space activities. This is because not all states have national space regulatory legal acts that regulate the order, methods, methods and legal regimes in the field of space activities. And those that have not been brought to a single pattern. That is, at the present time, it is problematic to ensure the transition to a new management paradigm, referred to as digital governance, at the global level. Despite this, there is still a need to develop a theory about the need for the existence of a global administrator. Its main function is the settlement of space commercial legal relations on the basis of both a linear-organized type and a linear-functional one, depending on the structure of the participants in such legal relations.

3. In the new conditions of social development, which is accompanied by comprehensive informatization, deep social transformations and globalization, we should rely on new models of organization and implementation of communication between government and society. An active, conscious civil society is needed to successfully build a digital democracy in Ukraine. It is also necessary to make the transition from public administration, even digital, to digital public administration. In Ukraine, there are significant prospects in terms of the implementation of digital democracy, some embryos of which already take place in law-making and law enforcement activities of public administration. But the sphere of space activities in this regard is still underdeveloped. Mainly due to insufficient funding for this industry. In the issue of digitalization of space activities, Ukraine seeks to follow the example of world leaders. A significant contribution of the program of digital governance of space activities will be the adoption of the Rules of registration of spacecraft of Ukraine, which will ensure such a procedure online.

The development of digital governance in space is an evolutionary process. On the one hand, this is due to comprehensive informatization, deep social transformations and globalization. On the other hand, there is a legal vacuum for the settlement of modern aspects of space activities. This necessitates the transition from formal bureaucracy to digital democracy in terms of legal regulation of space relations at the global and national levels. The main problem is that currently, the global administrator of space activities as a specialized institution that makes global legal decisions is absent. This encourages space powers to adopt national space regulations, which do not have a single model in terms of the content and nature of legal norms. This creates significant obstacles to the proper regulation of space activities, as no one has the right to interfere in the internal affairs of an independent sovereign state. At the same time, outer space is the property of mankind. Its development and use cannot be isolated. Access to information must be provided at all times. The exchange of information must also be continuous. Accordingly, the harmonization of global and national digital governance is a topical issue today and requires more specialized research.

In conducting further research, we will focus on the experience of space countries in the aspect of digital governance in the field of space activities. This will facilitate the search for concrete initiatives and proposals for the implementation of this model of organization and communication between government and society in the space industry in Ukraine. After all, modern experience in the digital governance of space activities in Ukraine is almost non-existent, although it has a basis for development.

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Liability for Violating the Procedure for Airspace Usage by Unmanned Aircraft in Ukraine

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The article presents a theoretical review and a new solution to the scientific problem of determining the nature and characteristics of liability for violation of the procedure for the airspace usage by unmanned aircraft, of characterising the concept and elements of liability, which has enabled to prove a number of new scientific provisions and conclusions aimed at improving the legislation establishing legal liability in the field under study. It is noted that, due to adopting a number of legal and regulations, important steps have been taken during the independence of Ukraine to improve the legal situation with regard to the airspace usage by aircraft. However, some substantive issues still remain to be properly addressed in this field nowadays. These are the legislative regulatory mechanism for the use of unmanned aerial vehicles, which makes the study presented relevant. It is noted that the current legislation establishes two key types of legal liability for violation of the use of airspace by unmanned aerial vehicles, in particular: criminal and administrative. However, it was emphasized that it is also expedient to distinguish a separate type of liability – disciplinary, which applies to persons who use unmanned aircraft in the performance of their labor (official) function.

Keywords: atmosphere, airspace, aircraft, aerial vehicle, unmanned aerial vehicles, liability, legal liability, legal regulatory framework, aviation activities.

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Introduction

The real challenges and the active digitalisation in society generate new problems at both the legislative and theoretical levels. For example, the need to improve the legal framework for the use of unmanned aerial vehicles, which are now used not only for entertainment and sports activities but also by different branches of business, for law enforcement, defense and national security, has recently been increasingly raised in academic circles and State authorities. However, despite the considerable attention of scientists, many issues, related to the airspace usage by unmanned aerial vehicles in general and legal liability for violations of the law in this field in particular, are of concern today.

The issues of the legal regulatory framework for airspace usage at the beginning of the 20th century were hardly violated and were exclusively theoretical (Moskalenko, 2017: 96; Kozlovsky & Boyarskaya, 2009). Although it should be noted that the desire to conquer the air has been shown by man since ancient times when they dreamed of flight, then fairy tales about "carpet-aircraft" appeared and later became a reality. It is no coincidence that legends such as the Daedalus and Icarus have appeared, where man has risen to clouds on man-made wings. In Kyiv Rus, the first chronicles of people's desire and attempts to take over the airspace are connected to the Nestor-Chronicler, but they were more a fiction and an unfulfilled dream at the time (Bagan, 2018).

The gradual scientific and technological progress of mankind has led to the development of the transport sector. The legal regulatory framework for aviation took place together with scientific research in various sectors of public life and the economic development of States and society. On 5 June 1783, brothers Joseph and Etienne Montgolfier launched the first public flight of a hot-air balloon, which they had long worked on. In November 1782, in the French town of Annonay, brothers Joseph and Étienne Montgolfier, for the first time, made a silk balloon of one-cubic-meter capacity. This is the beginning of the development of the aviation industry and the need for its legal and administrative framework. However, there was no legal regulatory framework for airspace usage and flights at that time, as this had not been required yet. Over time, vehicle traffic in the air grew due to stronger inter-State connections (Moskalenko, 2017: 96).

However, on 23 April 1784, France imposed a ban on flights over the city without permission in France. In other words, it can be considered that the legal regulatory framework for aviation security began from that time. In 1889, in Paris, the International Aeronautical Congress considered the ownership of balloons, the liability of aeronauts, the ownership of balloons, and the rescue of balloons and their crews. In 1900, the French jurist P. Foshil proposed a code of international air navigation. In 1902, at the University of Brussels at a scientific conference, the category "air law" was first used (Todorov et al., 2005: 308, 320; Moskalenko, 2017: 96; Lopatynska et al., 2020).

In view of the rapid development of aviation and the airspace usage by States for civilian and military purposes, the problem of the legal regulatory framework for relations on the use of that space has become a topical issue of practice. In view of this, the issue of the sovereignty of the state over its airspace arose. Consequently, an important provision in the doctrine and jurisprudence of air law was the recognition and consolidation of the full and exclusive sovereignty of a State over its airspace (Todorov et al., 2005: 334-337; Kozlovsky & Boyarskaya, 2009).

It should be noted that the problem of optimizing the legal basis of liability for violations of the procedure for the airspace usage by unmanned aerial vehicles has not been the subject of a separate comprehensive scientific study. Only in a fragmentary way did the study of the more general issues of airspace usage address certain aspects of the subject matter.

Therefore, the absence of comprehensive monographic studies on the problem and the existence of many gaps and shortcomings in the legislation in force, providing liability for violations of the procedure for the airspace usage by unmanned aerial vehicles, makes the study relevant and timely.

The genesis of the legal and regulatory framework for airspace usage by aircraft

In order to clearly define the potential and appropriate areas for further improvement and development of the legal framework for airspace usage by unmanned aerial vehicles, it is necessary to turn to the study of the historical background of the legal support for airspace usage by aircraft.

The problem of amending current legislation and making new legislation regulating the process of air transport, including international air transport, became acute immediately after the proclamation of State sovereignty of Ukraine. The declaration of freedom of business has resulted in a relatively large number of aircraft operators, most of whom are engaged in air transport. In fact, the State monopoly on this type of activity, which in the USSR was carried out by only one airline Aeroflot, was abolished. Consequently, a regulatory framework for air carriers and other transport stakeholders was required (Bagan, 2018). A number of measures were taken by the Ukrainian authorities to resolve these and other problems regulating airspace usage. In particular, the Air Code of Ukraine (1993 Code) was adopted in 1993 (Air, 1993).

The 1993 Code established that Ukraine has full and exclusive sovereignty over the airspace of Ukraine, which is part of the territory of Ukraine. The airspace of Ukraine is located above the land and water territory of Ukraine, including its territorial waters (territorial sea). According to Article 2 of the 1993 Code, it regulates the activities of users of the airspace of Ukraine with a view to meeting the interests of Ukraine and its citizens and ensuring the safety of aviation. The definition of aviation as an industry was established as follows: all types of enterprises, organizations and institutions activities are aimed at an enabling environment for man to use airspace by means of aircraft. The state, in accordance with the Code, regulates the activities of civil aviation through the central transport authority and the relevant aviation authorities in the following areas: civil aviation development; aviation safety oversight; certification, registration and licensing; management of airspace and air traffic services; provision of search and rescue for aircraft in distress; protection of Ukraine's aviation from acts of unlawful interference in its activities; scientific support for aviation activities and ensuring its safety, both by industry and interindustry scientific and scientific organizations and aviation enterprises; promotion of foreign economic and international legal activities of civil aviation.

In addition, provisions of the 1993 Code established the legal bases for the activities of users of Ukrainian airspace and the economic and commercial activities of aviation, aviation rules, and the legal status of aircraft, aerodromes and airports, the procedure for certifying and admitting air routes, aircraft flights, transportation and aviation work, etc. (Sobakar, 2016: 71).

Section XVI of the 1993 Code separately provided for liability for violations of the legislation governing the airspace usage. Therefore, article 89 provided for that all legal entities

and individuals engaged into the use of Ukrainian airspace, development, manufacture, repair and use of aircraft, economic and commercial activities, the servicing of air traffic, the ensuring of aviation safety of Ukraine, as well as its management and supervision, shall be subject to liability stipulated by the current legislation of Ukraine (Air, 1993). However, this law has not specified the types of liability, nature, and scope of sanctions. It should be noted that the 1993 Code made no mention of unmanned aerial vehicles, their status, and their use. Although the 1944 Chicago Convention, which had already contained a reference to unmanned aerial vehicles, as noted above, was ratified by Ukraine in 1992.

Subsequently, Ukraine adopted a number of other legal and regulatory instruments of different legal forces, in one way or another relating to the airspace usage by aircraft and aviation security. Over the years, however, the updating of the Air Code has become increasingly urgent. Since 1993, Ukraine has already become a member of the European Civil Aviation Conference (ECAC) and the European Organization for the Safety of Air Navigation (Eurocontrol), a candidate for the JAA membership, which, accordingly, requires amendments to Ukraine's aviation legislation. Nevertheless, the Code, in force at that time, from the very beginning has contained and still contains the concepts of Soviet air law and does not focus on the requirements of international law, even after it has been supplemented and amended. Five amendments to the current Air Code have been made during the entire period (Kozlovsky & Boyarskaya, 2009).

That is why, in May 2011, the Verkhovna Rada adopted the new Air Code of Ukraine (2011), which entered into force in September of the same year. The new Code adopted an updated approach to resolving a number of issues in the airspace usage (Kosse, 2011). The adoption in 2011 of the new Air Code of Ukraine was due to deepening cooperation between our State and foreign countries, primarily European countries, and the need to implement international standards at the national level on the airspace usage by aircraft and the safety of civil aviation. Ukraine should take into account international regulatory requirements in this field, since it is a full member of the International Civil Aviation Organization (ICAO), the European Civil Aviation Conference (ECAC), the European Organization for the Safety of Air Navigation (Eurocontrol) and is a candidate for membership in the Joint Aviation Authority (JAA), part of powers thereof have been transferred to the European Aviation Security Agency (EASA) (Kosse, 2011).

Positive aspects of the 2011 Code are 1) differentiation of government and civil aviation; 2) streamlining of aviation regulatory and supervisory functions and the organization of public administration; 3) the Authorized body for civil aviation, who implements public policy and strategy for the development of aviation in Ukraine, and is responsible for State regulation of civil aviation activities; 4) resolution of issues relating to the financing of general State expenditure on civil aviation; 5) implementation of public policy on licensing; State control of the activities of civil aviation enterprises of all forms of ownership related to the provision of services for the transport of passengers and cargo by air, in accordance with uniform rules and regulations; 6) in contrast to the previous Code of 1993, the new one provides for penalties for offences against entities of aviation in a very specific way rather than superficially. However, the 2011 Code does not guide other types of liability clearly and meaningfully.

It should be noted that the 2011 Code (articles 1, 39) refers to unmanned aerial vehicles, although the Code does not specifically regulate the airspace usage by these vessels.

In order to fully implement international requirements and standards in the sector under study, as well as to eliminate gaps and other shortcomings of the Code, a number of important

legal regulations have been adopted in recent years, such as: Law of Ukraine 1965-VIII "On the State programme of aviation safety of civil aviation" of 21 March 2017; Resolution 954 of the CMU "On approval of the Regulation on the airspace usage of Ukraine" of 6 December 2017; Order 637 of the Ministry of Infrastructure of Ukraine "On approval of the Procedure for imposing and punishing fines for violation of the requirements of the legislation on air transport" of 26 December 2011; Order 430/210 of the State Aviation Service of Ukraine, Ministry of Defence of Ukraine "On approval of the Aviation Rules of Ukraine "Rules of Use of Air Space of Ukraine"" of 11 May 2018, etc. The adoption of these and other legal instruments enable a number of important steps have been taken to improve the legal framework for the airspace usage by aircraft.

However, some substantive issues still remain to be properly addressed in this field today. This applies in particular to the legal regulatory framework for the use of unmanned aerial vehicles, which makes the study relevant. In general, it should be noted that, during the years of independence, Ukraine has taken many positive and useful steps towards the formation and development of national legislation on the airspace usage by aircraft. Despite the rather slow pace of change and transformation, as well as some problems in this field, generally, our state is on the right track. Comprehensive and informative theoretical studies on problematic issues of the legal regulatory framework for the airspace usage by aircraft should make the process of improving and developing legislation in this field more constructive and qualitative.

The concept, types of and grounds for liability for violations of the procedure for the airspace usage by unmanned aerial vehicles

The airspace usage, especially by unmanned aerial vehicles, requires the legislator to take a specific approach to establish liability for violations in current legislation in this field. In general, responsibility is a category of ethics and law that reflects the special social, moral and legal development of the individual towards society (humanity as a whole). It is characterised by the fulfilment of moral duty and legal norms.

Liability covers the philosophical and sociological issue of the relationship between a person's abilities and capabilities to act (as author) and more specific issues: the capacity of a person to act consciously, voluntarily fulfil certain requirements and tasks assigned; make the right moral choice, achieve a certain result (Bodnarchuk, 2016).

Therefore, it would be fair to suggest that the category of "liability" is multifaceted, which determines its use in a large number of fields of scientific knowledge, in particular:

1. In ethics, liability is a certainty, reliability, honesty towards oneself and others; it is awareness and willingness to admit that the result you obtain in your deeds and actions is the consequence of your deeds (actions) (Lukasheva, 1986: 683). As an ethical category, liability has several meanings: what a person is responsible for and to whom he/she is accountable. In this aspect, it is possible to highlight the responsibility of a person to oneself (making a choice "choose oneself" and bear the responsibility), responsibility for concrete deeds to other people, responsibility to mankind and the world (responsible for all). To be responsible is to think about others and the consequences of your deeds – whether they do harm to others (Baranova, 2015).
2. In sociology, liability is the responsibility of the individual (expressing the objectively necessary relationship between oneself and the community) to assess

one's intentions and to conduct himself or herself in accordance with standards reflecting the interests of social development and, in the event of their violation, (acts of irresponsibility) must be reported to the public and subject to public condemnation (measures of public coercion) or punishment (measures of State coercion) for anti-social conduct (Lipinsky & Khachaturov, 2007: 20; Podorozhnii, 2016).

3. In psychology, liability refers to the various forms of control exercised by a person over its activities in terms of compliance with the rules and regulations adopted (Karpukhin, 2001).
4. In philosophy, liability is a social and philosophical concept that reflects the objective-historical nature of the relationship between the individual and society, the individual and the social group formed in the course of satisfying mutual demands.

As a rule, according to the field of activity, liability is grouped into political, legal (juridical), moral, and depending on the actor, – individual, group, collective, etc. Liability is made due to those demands, society, the social group, the collective set. Absorbed by the individual, they become the basis of the motivation of one's behaviour. The formation of the personality implies a sense of responsibility, which becomes its main feature. Of particular importance is responsibility for certain activities in transitional societies that are in a state of maximum volatility, where the slightest fluctuations (in this case, they may be the actions of one individual) may lead to undesirable social bifurcations (Danilyan & Taranenko, 2003).

The study by F. Hyder is of interest, because he, as a criterion of responsibility, accepts the ability to withstand provocative circumstances, differentiates the direct consequences of action from unintentional but supposed. He identifies the following stages of liability: generalized liability, where the individual is responsible for any consequences of such acts in which he or she participated or in which he or she was involved in any way; own liability, where the individual is responsible only for what he has done directly, regardless of the result (incidental, intentional or presumptive); differentiated liability, where the actor is responsible for any intended result of the action, whether or not it has been intentional; conscious liability where the individual is responsible not only for his or her intentions and the consequences of their realization, but also for the importance that he or she attaches to external factors which, as a result, affect the result of the action in one way or another; full liability in which the individual is fully responsible for the course, results and consequences of the act, whatever the circumstances of the act (Savchin, 1997: 346; Patynok, 2012).

Therefore, we can state that liability is a broad and wide-ranging scientific category that is used in virtually every sector of public life and, in its most general form, represents a special relationship between the individual and the performance of his or her duties, as well as being responsible for his or her actions. It is fair to say that the concept of liability has been most explored from the legal perspective, which has given rise to a considerable number of approaches to its interpretation.

Consequently, the review of scientific positions reveals that legal liability for violating the procedure for the airspace usage by unmanned aerial vehicles is a measure of State coercion, which is applicable to the person for violation of legal regulations in the airspace usage. For the offender, legal liability means applying negative sanctions against him or her aimed at condemning his or her misconduct. It should be noted that current legislation provides two key types of legal liability for violations of the procedure for the airspace usage by unmanned

aerial vehicles, including criminal and administrative liability. However, it is emphasized that it is also appropriate to distinguish a separate liability – disciplinary – that applies to persons using drones in the exercise of their work (official) function.

The specificity of liability for violations of the airspace usage by unmanned aerial vehicles is as follows (Boldyreva, 2019):

1. It is characterized by a special subject of liability and by the range of public authorities empowered to prosecute.
2. The commission of an offence precedes the incurring of liability, which in turn has a specific structure, namely the object, the subject, the objective and the subjective sides.
3. It is aimed at punishing the guilty persons, which means that it is only retrospective.

The study of liability for violations of the procedure for the airspace usage by unmanned aerial vehicles requires to focus on the grounds and conditions for such liability. In fact, liability in a purely legal, that is, retrospective (negative) aspect, arises only on clearly defined grounds. In the dictionary literature, the term "ground" is interpreted as:

1. The lower, supporting part of an object, structure; the base.
2. The main thing on which something is based.
3. What explains, justifies the acts, behaviour, etc., of someone (Large, 2005: 572; Dictionary, 200: 332).

Therefore, the ground for liability under consideration is what makes the existence of the concept necessary, what justifies the need and justifies the application of appropriate measures and penalties to individuals.

The sole and factual ground for legal liability is the commission of an offence that constitutes an offence.

The offence is a set of the grounds specified in the law, where a dangerous or harmful act is considered to be a specific offence. Such characteristics are objective and subjective (Kolodii & Oliinyk, 2009). Objective characteristics are an object and an objective aspect, and subjective ones are a subject and subjective aspect.

Therefore, the analysis of the articles of the current Ukrainian Code on Administrative Offences (articles 111 and 112) and the Criminal Code of Ukraine (articles 281 and 282) enables to distinguish public relations with regard to air safety as an object of unlawful encroachment (Scientific, 2017: 152-155; Criminal, 2001). Air flight safety, according to the AC of Ukraine, is a state in which the risk of damage or harm is limited to an acceptable level (Air, 2011). Flight safety is further developed in the Instruction on the Procedure for monitoring the financial and economic viability of operators' compliance with aviation safety rules and regulations (On Approval, 2005). However, an examination of the Content of the Regulations on the use of Ukrainian airspace reveals that violations in this field infringe not only on relations on ensuring the safety of flight and protecting the life and health of citizens, but also on relations on State border protection, ensuring national and economic security. Consequently, we believe that the object of offences in the airspace usage by unmanned aerial vehicles is public relations to ensure the proper (legal and safe) use of airspace by unmanned aerial vehicles. With regard to these relations, established requirements are being implemented for the organization of the use of Ukrainian airspace in the interests of national security and the economy in order to meet the needs of airspace users, ensuring the safety of the airspace usage (On Approval, 2017). Therefore, the danger of the disruption of these social relations is that it

increases the risks of harm to life, health, property, other rights and legitimate interests, as well as to the rights and interests of the state and society in general.

One of the objective aspect features of violations of the procedure for the airspace usage by unmanned aerial vehicles is that the acts (omissions) constituting the content of the offence are provided for both in the UCoAO and in the by-law, namely in Resolution 954 of CMU "On approval of the Regulation on use of air space of Ukraine" of 6 December 2017. Therefore, according to article 111 of the Code, violations may take the form of (Code, 1984):

1. The placement in the aerodrome area of any signs and devices similar to the identification signs and devices adopted for the identification of aerodromes, or the burning of pyrotechnic articles without the permission of the airport or aerodrome administration, or the establishment of facilities, contributing to a massive gathering of birds hazardous to flights of aircraft.
2. Failure to comply with the rules on the placement of night and day identification signs or devices on buildings and structures.
3. Damage to aerodrome equipment, aerodrome sign, aircraft and their equipment.
4. Pass or drive through the territory of airports (other than air terminals), aerodromes, radio and light facilities without proper authorization.
5. Flights in violation of aviation regulations.

Of particular interest to us is the latter, that is, flights in violation of aviation regulations. Obviously, this legal provision is blanket, meaning that it does not refer to specific manifestations of such violations, which leads to recourse to other legal regulations. Therefore, in accordance with Article 127 of the AC of Ukraine and Part 46 of Resolution 954 of the CMU "On approval of the Regulation on the airspace usage of Ukraine" of 6 December 2017, violations of the procedure for the airspace usage of Ukraine include (Air, 2011; On Approval, 2017):

1. The airspace usage without application, authorization and/or conditions for its use, except as provided for in this Regulation.
2. Non-compliance with the conditions for the use of Ukrainian airspace or with the flight plan (deviation from the route, the specified level of flight, take-off or landing of an aircraft from an unplanned (on an unplanned) or closed aerodrome, a permanent aerodrome/heliport, etc.) without the authorization or coordination of the air traffic service (air traffic control) authority, except in the case of an accident.
3. The flight of the group of aircraft exceeding the number specified in the application.
4. Violation of requirements concerning the procedure for crossing the State border and a flight in a zone with a special regime for the use of Ukrainian airspace.
5. The flight of an aircraft in the prohibited zone or restricted-flight zones and in the temporarily reserved airspace of Ukraine during their use without authorization.
6. The flight of an aircraft which does not respond to a request from a State radar recognition system other than an aircraft, where State recognition radar equipment is not available, or which returns with defective State recognition radar equipment from aerodromes, landing sites/heliports, where repair of such equipment is not possible.
7. Failure to comply with the requirements to inform the monitoring bodies of compliance with the procedure for the use of Ukrainian airspace concerning flights and other activities involving the use of Ukrainian airspace.

It should be noted that some of these acts are not considered offences if flights are performed using unmanned aircraft up to 20 kg inclusive. In particular, flights of such types of unmanned aircraft are carried out: without submitting applications for the airspace use, without obtaining permits for the airspace use, without informing the Air Forces of the Armed Forces of Ukraine, the Integrated Civil-Military ATM System (ICMS) and the State Border Service of Ukraine, air traffic services and air traffic control. However, the following conditions should be met:

a) Flights are performed without crossing of the state border of Ukraine;
b) Flights are performed outside the established airspace use prohibitions and restrictions, except as provided for in the Regulation on airspace use;
c) Flights are performed neither closer than 5 km from the external boundaries of runways of aerodromes, nor closer than 3 km from the external boundaries of the runway of landing sites/heliport unless agreed with the operator of landing sites/ heliport operator;
d) Flights are performed not closer than 500 meters from manned aircraft;
e) Flights not performed over: (1) assemblies of people at open-air and tight city construction; (2) the objects (zones) defined by the Ministry of Defence of Ukraine, the Ministry of Infrastructure of Ukraine, the Ministry of Internal Affairs of Ukraine, the State Border Guard Service of Ukraine, the Security Service of Ukraine, the National Police of Ukraine, the National Guard of Ukraine, the State Fiscal Service of Ukraine, the Foreign Intelligence Service of Ukraine, the State Protection Department of Ukraine, other military formations and law-enforcement structures formed in accordance with the laws of Ukraine and in respect of which protection / State protection is carried out (subject to the indication of the territory surrounding these objects with information signs of prohibition on unmanned aircraft flight and/or by announcing the limits of such prohibition), except for flights authorized by the above-mentioned authorities;
f) Flights are performed within visual line of sight (VLOS);
g) Maximum fly altitude: (1) 120 m above the ground (water) surface outside CTR, AFIZ, ATCA, ATCZ, specially designated zones and routes, other specially reserved portions of airspace of State aviation; (2) 50 m above the ground (water) surface within the limits of CTR, AFIZ, ATCA, ATCZ, specially established zones, reserved airspace to provide flights on specially designated State flight routes or if the information on the actual status of elements of the airspace structure at the time of flight is not available; 50 m above terrestrial (water) surface within the limits of CTR, AFIZ, ATCA, ATCZ, specially designated zones, other reserved portions of airspace, if there is no information on the actual status of elements of the airspace structure where flight is planned; (3) 50 m above static obstacles at a horizontal distance of not more than 100 m from obstacles such as a deviation from the above-mentioned height limitations, at the request of the owner of such object;
h) The operating speed of unmanned aircraft is not more than 160 km/h.

In other cases, unmanned aircraft weighing below 20 kg inclusive and all operations of unmanned aircraft weighing more than 20 kg without exception, are performed within specially defined zones and routes complying with the requirements for submitting applications for airspace usage, obtaining permits and condition of airspace usage, informing the appropriate

units of Air Forces of the Armed Forces of Ukraine, the units of the State Border Guard Service of Ukraine, the ICMS units, the ATS units (On Approval, 2018).

Therefore, violations of the Regulations governing the airspace usage by unmanned aerial vehicles can take the form of active actions in violation of the regulations, prohibitions in this field and passive forms, i.e., omission of actions required by law with regard to the legality and safety of the use of unmanned aerial vehicles in the airspace of Ukraine.

It should also be noted that the offences under study are composed technically. That is, harmful consequences are not a necessary element of their objective aspect, only the fact that a person has committed action (acts, omissions) is sufficient in violation of legal requirements.

The offender is a criminal individual or legal entity that has committed offences in the airspace usage by unmanned aerial vehicles. It should be noted that under the legislation in force, only financial sanctions may be applied to legal entities, as is clear from article 127 of the Air Code of Ukraine. However, administrative and criminal liability is imposed on individuals, including officials, for violations being investigated.

The entities, liable for offences committed in the field under study, are airspace users, such as the directors of aircraft enterprises, organizations, owners or external pilots of unmanned aircraft, other persons planning or carrying out aviation activities to use unmanned aerial vehicles (Code, 1984).

Next, the subjective aspect of the offence implies the offender's mental attitude to the acts (omissions) committed and their consequences. That is, the subjective elements of the offence are the guilt, motive and purpose of the offence. In addition, the guilt is a constitutive (attributive) element of the subjective aspect of the offence, and its main forms are intent and negligence, manifested in the committed offence (Administrative, 2004: 433). An administrative offence shall be admitted intentional when the person who has committed it has been aware of the unlawful nature of his/her act or omission, provided for its harmful consequences and desired or knowingly allowed these consequences to occur (Code, 1984). Accordingly, an administrative offence shall be admitted negligent when the person who has committed it contemplated possible harmful consequences of his/her act or omission, but recklessly counted on their averting or has not foreseen the possibility of such consequences, although he/she should and could have provided for them (Code, 1984).

Therefore, the current state of affairs in the legal regulatory mechanism for liability for violations of the airspace of unmanned aerial vehicles requires improvement in a number of aspects, such as clarification of the requirements for the object and the subject of the offences in this field; settlement of the ways in which offences are committed and their harmful consequences; expansion of the range of administrative penalties for such offences, etc.

Conclusions

Therefore, liability for violations of the rules governing the airspace usage by unmanned aerial vehicles requires a specific approach to making the legal regulatory framework for the matter. An efficient legal regulatory framework for the sector determines compliance with key principles of liability such as legality, the rule of law, expediency, justice, etc. Undoubtedly, this is an important guarantee of respect for the rights and freedoms of both the offender in question and the person authorized to prosecute the offender.

It is proved that legal liability for violating the procedure for the airspace usage by unmanned aerial vehicles is a measure of State coercion, which is applicable to the person

for violation of legal regulations in the airspace usage. For the offender, legal liability means applying negative sanctions against him or her aimed at condemning his or her misconduct. It is noted that current legislation provides two key types of legal liability for violations of the procedure for the airspace usage by unmanned aerial vehicles, including criminal and administrative liability. It is emphasised, however, that it is also appropriate to distinguish a separate liability – disciplinary – that applies to persons using drones in the exercise of their work (official) function.

With a view to improving legislation, which establishes the legal principles of liability for violations of the procedure for the airspace usage by unmanned aerial vehicles, it is proposed: 1) to define conceptual principles for the control of the airspace usage by unmanned aerial vehicles and liability for offences in this field; 2) to regulate by law the scope of actors liable for violations of the procedure for the airspace usage by unmanned aerial vehicles; 3) to authorize officials of the National Police and the border guards to draw up reports on offences in this field; 4) to expand the scope of penalties for offences in this field.

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Mission to Mars: Medical and Legal Aspects of the Protection of Human Rights to Life and Health During Long-Lasting Space Missions

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The article deals with the delay between the evolution of functioning of the body and the social revolutionary transition from the Earth people towards Space people. As a result of this natural phenomenon, the legal protection of human rights to life and health for the human explorers of outer space is needed. This need is encouraged by the plans of certain governments and private space companies on accomplishing the mission to Mars in the middle-term perspective. The article follows the scientific proposals to update legal responsibility of states to ensure the life and health of astronauts and space tourists sent by them. The article applies general and special scientific methods to comprehend and study social and legal phenomena and general logic reasoning (abstract reasoning, analogy, analysis, generalization, etc.). Consequently, the article authors conclude that the UN should adopt the Declaration on Human Rights in Space to formalize the legal protection of human representatives sent to space.

Keywords: human rights, life and health, legal protection, space, Mars, envoys of mankind.

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Introduction

There would be a long and full of marvellous experience, joined by the multiple threats for human lives and health, the way towards Space People. This path would be defined by both the breakthrough achievements of the Humanity and human genetic evolution. Nonetheless, at any given stage the human rights, especially the rights to life and health, of the space explorers should not be violated.

Humanity is at the early stages of conquering outer space. Consequently, governments and private companies should provide the rights of life and health for the crew members of the space exploration missions.

This issue of the provision of the rights of life and health for people on space exploration missions is the article's primary focus. The basis for the research is laid by the scientific bio-medical research on the environmental factors influencing the astronauts' health (Urrutia, 2020; Coady, 2017; Roberts et al., 2019) a and the space legislation in effect (Treaty, 1967; Agreement, 1968).

There is an overview of international and Ukrainian national legislation regarding human rights of life and health protection during the outer space missions in the first part of the article. It was made clear that the regulation of this matter is regulated by the international norms of the space law (Treaty, 1967; Agreement, 1968) and the national space law of some countries (Hoda, 2021). Nonetheless, both international and national laws have imperfections and gaps and cannot ensure the natural rights of humans during long-lasting space exploration missions. They require both theoretical development and implementation of new legislation.

The second part of the article discusses the challenges for humanity in the protection of the rights of life and health of people in space during the long-lasting space missions. The conducted analysis of the available studies proves the existence of a number of life and health threats for

the astronauts on a long-lasting space exploration mission beyond the electromagnetic field and microgravity of the Earth. Therefore, before sending people for the long-lasting space missions there is a need for sound theoretical and applied research, for instance, sending and welcoming back a few Missions to Mars with living creatures.

The third part of the article is devoted to human evolution on the way from being a living creature born on the planet Earth towards the space living creature. It is made clear that such transition from Earth-living to space-living would not cause an immediate positive effect on our physical body. Nevertheless, in the long run the unfavoring space conditions would enhance not only the intellectual development but also the physiological evolution of the human organism. Therefore, the majority of humans would be able to live outside the Earth planet. There would be a protracted transition period. Before humanity had adapted to the space environment, the studies should be conducted in a steady and evolutionary manner. In general, as of now, we suggest limiting the time people can spend in outer space to protect their rights of life and health accordingly.

The fourth part of the article identifies the threats for people on missions to Mars and the legal framework that should be in place to protect human rights of life and health. There is an overview of the life-threatening factors of the open space and the environment created by Mars' surface that is not favorable for living on the planet. The importance of the further research, using pilotless spacecrafts with and without biological material on it, is stressed. It is proven that the safety issues of the mission to Mars with people on board are caused not by technological flaws but merely by biological, humanitarian and legal obstacles.

In conclusion, the authors stress the importance of the UN to adopt the Declaration of Human Rights in Space as the governing international law in the space legislation field.

The state of the field in international and national legislative regulation of human rights of life and health

According to Article III of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies from the 10th of October 1967, the activities should be conducted "in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding." According to Article V, "States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the state of registry of their space vehicle (…) States Parties to the Treaty shall immediately inform the other States Parties to the treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts" (Treaty, 1967).

This Treaty was further developed and supported by the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space from the 3rd of December 1968. It states that "each contracting party which receives information or discovers that the personnel of a spacecraft have suffered accident or are experiencing conditions of distress or have made an emergency or unintended landing in the territory unders its jurisdiction or on the high seas or in any other place not under the jurisdiction of any State

shall immediately: (a) notify the launching authority or, if it cannot identify and immediately communicate with the launching authority, immediately make a public announcement by all appropriate means of communication at its disposal; (b) notify the Secretary-General of the United Nations, who should disseminate the information without delay by all appropriate means of communication at his disposal (…) It shall immediately take all possible steps to rescue them and render them all necessary assistance" (Agreement, 1968).

Thus, astronauts are first of all "envoys of mankind in outer space." Nevertheless, that does not imply that they lose their legal bond with the nation they hold the citizenship of. Accordingly, humans in space retain all rights and obligations occurring from their citizenship. Moreover, the laws of the nation that has registered a space vessel should be followed and respected by the workers and travelers on it. Astronauts are perceived as "envoys of the mankind" and also hold their citizenship status. Consequently, humans in space and their rights of life and health are protected by both international law and the national law of the countries whose citizenship they hold (de Gouyon, 2019).

For instance, in the USA, an astronaut was considered a human traveling or preparing (going through the training program) to fly beyond the Earth's atmosphere (Hoda, 2021). According to the Cambridge Dictionary, an astronaut is "a person who has been trained for travelling in space" (Astronaut, 2021). We see that the first and the second definition of the legal status of astronaut do not match. The first one states that an astronaut is any person who is professionally or by any other means is being prepared to fly beyond the Earth's atmosphere. The second concerns only a person who is professionally trained for travelling in space. The second approach is supported by the Russian scientists. They relate a status of "cosmonaut" to the job functionality. The legal status of cosmonauts is thus seen through the lens of professional activities during the space missions (Baturin, 2020).

Recently, as the reaction on the wider spread of the commercial suborbital flights there has been a proposal to call people who have been trained and are conducting scientific, educational, media, civil functions on the board of a spacecraft as "private astronauts" instead of labeling them as "space tourists" since they are civic explorers of space environment (Tumlinson, 2021).

A great example of this is the first Jeff Bezos' flight on the reusable suborbital rocket system New Shepard. He could not considered neither a crew member nor a human who contributed to the safety of the human space flights during the flights. Due to these reasons, he and other people who were on board of SpaceX Crew Dragon and Virgin Galactic SpaceShipTwo were rejected to be awarded commercial astronaut wings. In total, there were 15 people, including Richard Branson and Jeff Bezos, who took part in the private spaceflights. All of them did not received commercial astronaut wings from the FAA. Later, the Federal Aviation Administration adopted the decision that all people who were in space on board of private spaceflights as passengers during 2021 would still be awarded (Hoda, 2021)

There are not so many differences in the status of people in space for the purposes of our research as we are interested in developing a legal framework to protect any human who is out the Earth's atmosphere. In our opinion, people in space could be divided into three main categories:

1. Paid professionals who navigate space vehicles and (or) conduct scientific research in space. According to the tradition of the country which they represent or the flag on the board of the space vehicle, they could be called astronauts (the USA), cosmonauts (Russian Federation), taikonaut (PRC), etc.

2. Private researchers (private astronauts) who conduct space scientific research provided by private entities or their own means.
3. Space tourists.

In general, both international and national norms of legal protection of human rights of life and health are at the early stages of their development. They have imperfections and gaps and cannot ensure the natural rights of humans during long-lasting space exploration missions.

The challenges for humanity in the protection of the rights of life and health of people in space during the long-lasting space missions

As of now, private spaceflights are at the active development stage. Private entrepreneurs target their efforts towards the colonization of the neighboring planet Mars. There are objective factors influencing such a situation. First of all, it is the nearest planet to the Earth, and moreover, the short-term stay of the living organisms, probably including people there, should not cause real-life and health threats.

However, the research of the state of health of astronauts who spent a long period of time in space, even in the suborbit (400-500 km) shows that it causes bad effects on them and requires long recovery after that (Hofman, 2014). This happens disregarding the fact that at the suborbital heights astronauts were under almost full protection of the Earth's magnetic field, and their organism is still so close to the Earth's surface that there is a micro-gravitation and people feel it (Urrutia, 2020).

Scheduled missions to Mars and to the other locations with the need of the long-term stay in outer space require a profound understanding of the effects of space flights on human bodies and behavior. The studies conducted during the last decade have shown two related influence patterns of spaceflights on human organisms and behavior. They are dysfunction and adaptive plasticity. The evidence shows that space factors during the spaceflights are unfavourable environment for humans in general and their brains in particular (Hupfelda et al., 2021).

There are analytical studies of the impacts of long-lasting space missions on human health to be addressed. American researchers made brain MR imaging scans of NASA astronauts to retrospectively analyse structural pre- and post-flight changes. They compared structural changes with cognitive and motor functions and came up with the following results: long-lasting spaceflights aboard the International Space Station resulted in a significant increase in total ventricular volume. In addition, long-duration spaceflights resulted in significant crowding of brain parenchyma at the vertex that correlated with the motor tasks completion time. "These findings suggest that brain structural changes are associated with changes in cognitive and motor test scores and with the development of spaceflight-associated neuro-optic syndrome" (Roberts et al., 2019).

Hence, there is no doubt that long-lasting space missions are dangerous for modern humans even if they are close to the Earth's magnetic field and microgravity (400-500 km on the suborbital height). The danger of the life and health of astronauts outside the Earth's magnetic field and microgravity could be tremendously higher. Although, there are only hypotheses on the possible rate of harm during the long-lasting space missions, since apart from the short-term travels to the Earth's satellite Moon, there were no other destinations of the human space travels. Before sending people for the long-lasting space missions, there is a need for sound

theoretical and applied research, for instance, sending and welcoming back a few Missions to Mars with living creatures (from unicellular organisms to those whose genetic structure is approximate to humans). These issues require legal regulation based on the national legislation of the space nations capable of conducting space missions. Consequently, these efforts to be supported by the norms of the international space law, adopted by the UN and ratified by the sovereign nations.

Human evolution on the way from being a living creature born on the planet earth towards the space living creature

Contemporary science proves that multicellular organisms went through their evolution (revolutionary mutations) nowhere else but the planet Earth. There are ongoing discussions on the origin of the unicellular organisms on our planet. This does not have much relevance for our research since Homo sapiens, according to the prevailing scientific theory as a living species, appeared as the result of the revolutionary mutation around 200 000 years ago. There are still opposing theories. Some claim that it was a steady evolutionary process for many people that lasted during 400 000 years (Hublin et al., 2017). For the purpose of our research, there is not much difference because in both cases, it is just a tiny period of the total life development. The Earth and its biosphere have dramatically changed during the last 4.5 billion years. The challenging life conditions appeared approx. 600 million years ago. During the first two billion years (4.5-2.5 billion years ago), ecosystems were solely dominated by microbial communities (Stüeken et al., 2020). Nonetheless, we due to the evolutionary changes, natural selection, revolutionary natural and social transformations have managed to achieve a great success within such a short period of time. Our success is much greater than any of other living species have ever achieved (Bakker, 1986).

It's noteworthy that the main evolutionary transformations of our ancestors were made during the first 100 000 years. The public and legal stage of human development enhanced social, scientific, humanitarian and technical development within the last 5 500 years.

We should stress again that the basis of human evolution is the development of the brain. The brain is the primary repository and building block of our experience and reality (Holloway, 2008).

Human brain is one of the most complicated and fascinating organs that has ever been developed. Progressive enlargement of the hominid brain started about 2.5 million years ago, most probably from an australopithecine form with a brain size comparable to that of a modern chimpanzee. Lately a threefold increase in endocranial volume has taken place. That has lead to one of the most complex and efficient structures known in the animated universe, i.e., the human brain. The evolution of the human brain is mainly explained by focusing on selection pressures of the physical environment (e.g., food and its availability, climate) and the social environment (e.g., size of the group, formation of the coalitions, parental care) (Hofman, 2014). We believe that the further development of the hominid brain would be enhanced by the need to adapt to work, life and rest in outer space where there are no protection properties of the Earth's biosphere.

Nevertheless, one should note that at the present stage of evolution, human presence in the outer space has a negative effect on the astronauts' health. For instance, it was proven by Steven Jillings, a doctoral student at the Lab for Equilibrium Investigations and Aerospace (LEIA) at the University of Antwerp in Belgium. He and the team studied the brains of 11

cosmonauts before their spaceflights, then again nine days after landing, and then again six to seven months after their return to Earth. This allowed scientists to have a more in-depth look at the brain landscape and see how spaceflight has really changed it. They concluded that the human body was designed to function under the Earth's gravity, so many of its parts have evolved to respond to the downward pull. These biological systems change when humans (and other mammals) spend a reasonable period of time in the Earth's orbit. The microgravity environment causes a sensation of weightlessness to appear. The first few days in outer space disorientate the space crew members and the lasting impact of the microgravity means they will need a period of time to re-adopt to the gravity when they are back on the Earth. They found that cosmonauts who had served six-month missions on the ISS experienced upward shifting of their brains, and that the fluid found around the brain and spine redistributed as a result of being in microgravity. Steven Jillings proves that various MRI techniques in future related research could help scientists get more information about the brain in space, like whether or not spaceflight causes any structural change to the brain itself (Urrutia, 2020).

The further transition of people into outer space should lead to a certain degree of human evolution. This would be caused by the fact that the space environment is aggressive towards humans and is the unfavorable natural environment. The fact that a large amount of people would have to spend their time there would ultimately lead to the adaptation to it. The evidence for such a statement is given by the scientists who believe that the leading positive effect on brain size was caused by the unfavorable natural environment conditions. However, there are objective limits to the growth of our brain in the future.

The human brain evolved from a number of the basic structures that limit the size and the amount of information that it can store and process. It means that internal factors of brain design could be the main determinants constraining the evolution of the brain. The new functional organization of the brain does not immediately evolve in response to specific environmental conditions (Hofman, 2014).

Therefore, the transition of human habitat from the Earth to space would not immediately cause the positive effect on a biological organism. Nonetheless, we are sure that unfavorable conditions in the long perspective would be the primal cause for not only the intellectual development but also for the physiological change in terms of the density of neural connection in our brains and the increase in the size of the brain. Importantly, that to implement a positive change in a natural way, the long amount of time is needed. The natural evolution of the living nature is reasonably slower comparing to the revolutionary changes of technologies, social and humanitarian systems where people achieve change within quite limited amount of time. Human evolution is really a slow process that would keep lasting for decades, hundreds, thousands and millions of years. Thus, rushing to send people to the long-lasting space missions would not be a smart thing to do. We have no doubts that humanity will live out of the planet Earth in some time. We are at the early stage of this process. This process could be enhanced by genetic engineering. However, in the majority of countries that have the potential to do so, experiments on human beings are prohibited.

Consequently, before humanity has adapted to the space environment, its exploration should be conducted steadily and in an evolutionary manner. The approach here should be a simple one. As of now, we have mastered the living of astronauts on the suborbital hight. The short-term missions to the Moon are the next step. Meanwhile, an artificial electromagnetic Earth field system, gravity and ozone layer emulators should be created. This would steadily increase the time human missions can spend their time on the Moon. This will slowly allow

(in a span of decades) to move to the concept of the space isles that would rotate around the Sun at a close distance from our planet. These all measures together with the applied research of missions to Mars and back with the living creatures on board would ultimately be allowed human missions to the Red Planet. The further steps of exploring the Solar system and beyond we cannot analise so far. Otherwise, we will move from scientific research to the sci-fi story. We have too many scientific gaps here. We are confident that there would be a point of time when people would be able to travel to the neighboring planetary systems.

Above-mentioned information leads us to the conclusion that we should lay the legal limitations for the duration of human stay in outer space to protect their rights of life and health. These limits should be correlated with the technical capacities to create emulators of artificial electromagnetic field of the Earth, gravity and other protections needed to protect a human on board of space vehicles (isles) in outer space. The lesser requirements could be applied only for the short-term stays and to foster the steady evolution of human organisms so that they could adapt to live and work beyond the Earth atmosphere.

The threats for humans on missions to mars and the legal framework that should be in place to protect human rights of life and health

NASA and certain private space companies plan on sending humans to Mars by 2030th. This is an ambitious plan of the return flight. It is planned that such missions would last from three to six months. Moreover, it is expected that the crew would stay on the Red Planet for up to two years period before the planetary situation would allow them to come back (NASA's, 2014). This means that astronauts would have to live under the conditions of the lower gravity (microgravity) for a period of approximately three years. That would greatly exceed the top non-stop stay in the space of cosmonaut Valery Polyakov, which is 438. The majority of the technical issues related to the mission are at the development stage (Stofan, 2016). However, we believe that the medical and legal issues to protect human rights of life and health of the astronauts during the mission to Mars lack attention. We believe that technical issues will be successfully solved. The main thing is not the technical possibility to send and welcome back the space vehicle on the mission to Mars but to overcome the effect of negative space influences.

Thus, according to the scientists into the space medicine field, the main negative natural factors that would affect the crew members of the mission to Mars are:

a) The influence of microgravity on the human organism (or the relative absence of it);
b) The absence of the protecting Earth's electromagnetic field;
c) The absence of the protecting ozone layer.

These are the main issues. However, there probably are more of them since there is a lack of time, and too few astronauts have been studied to understand the effects of outer space on human health.

The danger of the lack of gravity in outer space and very low gravity on Mars is the most studied one. It is a great issue since humans went through evolutionary development to exist with the Earth's gravity and not with the absence of it in outer space or with the low gravity on Mars. Biomedical scientists have proven that human brains have difficulties to cope with microgravity even though the data is scarce. They report that astronauts' faces become red and inflate with the absence of gravity. This effect is tenderly called after cartoon character

Charlie Brown or else "Bird-legs Syndrome." It is caused by the liquid (mostly consisting of blood cells and plasma) and stroke volume is moving to the head that causes puffiness in the face, and the legs are losing the volume. Such a liquids' shift is related to space motion sickness, headaches and nausea. Recently it has also been connected with blurry vision caused by the increased pressure because the blood flow in the tissues increases and the brain is lifted inside the skull. These are abnormalities with the astronauts' vision and are known as increased intracranial pressure. Even though NASA considers this as the highest health-related risk for any mission to Mars, it is still unclear for the medical scientists what exactly causes it and, what is even more important, how to overcome it (Urrutia, 2020).

Another issue is the negative impact of outer space on the human vestibular system. The otolith, located inside the inner ear, allows the brain to receive information that tells it how the head is oriented. Small crystal structures "Otoconia" create an Otolith that lies flat on top of a gel in the human's inner ear. Thus, when the head makes a movement, i.e., tilting down to one shoulder, gravity pulls the otoconia down across hairs within the human's inner ear. These movements are sending a signal to the brain, meaning the head has tilted. However, even though the head changes position in microgravity, there is still not enough gravity to tell the brain. "The first several days in space are disorienting for space crew members, and prolonged exposure to microgravity means they need a period of readjustment to gravity when they come back down to Earth" (Urrutia, 2020).

Additionally, there is an issue that the soil on Mars is not suitable for bacterial life and agriculture. Moreover, according to the estimations of biologists, Mars' soil is dangerous for human life and health (Coady, 2017).

A separate issue is the giving birth to children on Mars. Right now, scientists are not aware of how to make it possible. However, there are sound scientific works on the issue concerning space stations' environment. They stress the fact that giving birth in space is a challenge. First of all, because of the absence of gravity, it would be inconvenient for people to have sexual life in space. Even if they succeed, it would be just a minor problem. Secondly, human sperm cells need gravity for migration to the female's egg, which would make it even more difficult for the egg to be successfully fertilized in space. Thirdly, it is more difficult for the embryo to mature into a baby since there would be a changed flow of fluids from the mother's body to the embryo. After the possibly successful delivery, the main issue would be to comfort the baby to sleep. For children born in space, the return on the Earth would be harmful to experience local gravity. Similarly, mice born in space that have been studied had fewer problems in accustoming to weightlessness, although they had a very hard time coming to terms with balance. Babies born in space would look a bit different in cosmetical terms. Humans born there would develop bloated bodies and puffy faces. Since the heart doesn't have to work against gravity in space, it would atrophy, and we would lose blood content, making us paler and weaker. Since their hearts are not used to the Earth's gravity, they will have increased blood pressure in the upper bodies, their eyes would bulge and their brains would lose efficiency. The effects of the radiation levels that could be possible due to the prolonged stays at the ISS were studied on mice. They have shown an increased probability of suffering from Alzheimer's disease. Moreover, the astronauts on the ISS have experienced a degradation of their immune systems and had fewer white blood cells (Gupta, 2021).

The biological challenges of dangers of outer space and the unfavorable nature of Mars' soil for life on Mars mean that to protect human rights of life and health, mission on Mars

should be temporary legally banned. To allow the planned mission to Mars additional scientific research is required both robotic flights and with living creatures on board to fly there and back for the sound research. It would be an inhuman step to send people on a mission to Mars before finding the proper protection against unfavourable factors of outer space on the DNA similar to human DNAs.

Thus, today's obstacles of the human mission to Mars are not of technological nature but of biological, humanitarian and legal origin. The primal one is an effective legal protection of human rights of life and health in outer space.

Recent achievements and increased investments in human spaceflights have speeded up the terms of making the human missions in outer space, including those to Mars, possible. The success of such missions depends on the capability of managers to ensure the health and efficiency of people. Keeping motor, somatosensory and cognitive functions is of great importance for fulfilling the tasks on the board of the space vehicle, so the integrity of the Central nervous system (CNS) and the brain are in the focus of scientists. The observations of the spaceflights have reported decrements in operational performance. Crewmembers of the short-duration Apollo-era missions had reported altered driving performance on lunar excursions. More to that, during the first 100 Space Shuttle Missions, 20% of orbiter landings were outside acceptable limits. Observations also noted in-flight performance decrements aboard Mir and the ISS, including several close calls and one collision between a vehicle and components of the space station. Even though current and future generations of NASA spacecrafts have been prepared for autonomous flight, the crew must be capable of manual operation of the vehicle if the automatic control fails. Previously conducted studies have reported changes across multiple neurologic domains, including changes to sensation, movement, coordination, and cognition after spaceflight. For instance, a major potential cause of performance decrements during spaceflight was said to be sensorimotor dysfunction. Sensorimotor deficits observed during and after spaceflight included: reduced fine motor control, impaired gaze control, impaired coordination, loss of motor efference, postural ataxia and spatial disorientation. Whereas these changes are greatest immediately after gravitational transitions, it is noted that the extent and duration of some alterations have been associated with increased duration of the mission: e.g., poorer landing accuracy in the pilots of Space Shuttle was associated with longer mission length and greater extent of vestibular dysfunction, as seen from the post-flight assessments. It included vestibular deprivation, zero gravity and shifts of head liquids. Additionally, there is more evidence of other factors influencing the brain during spaceflights: isolation and confinement, space radiation (Roy-O'Reilly et al., 2021).

Based on the empirical evidences we believe that human long-term space missions beyond the Earth's electromagnetic field and gravitation should be regulated by national laws of space club nations who have the possibility to conduct such activities and should be framed by the norms of international space law. In our realities these requirements concern the mission to Mars.

The declaration of human rights in space

The primal humanitarian value is human life and health. Everything else, including scientific achievements and private individuals' ambitions, is of secondary importance. Therefore, before the issue of the biological and legal protection of crewmembers, sending a human mission to Mars would be an unbalanced decision.

Having said that, we are not against the transition of humans from the Earth to space reality. This is a natural and inevitable process. But to implement it, the rights of life and health of the mission's crew members have to be legally secured. It was repeatedly proven that the legal regulation should start from the national level and then lead to the UN's Declaration of Human Rights in Space After it would be ratified by sovereign nations, it would lead to the unification of national legislation in this sphere.

There is already the Universal Declaration of Human Rights as a foundation for the new document. The existing Declaration, according to Léopold Eyharts, Astronaut of the European Space Agency, "has found it's a symbolic place among all peoples of the world" (Universal, 2018).

The issues of ethics and human rights correspond to the aims of the Space Treaty of 1967. With the support of the Space Generation Advisory Council (United Nations Public Service Awards) and The Office of the United Nations High Commissioner for Human Rights, there is a working group on ethics and human rights that particularly works on the space issues. According to its specialists space technologies can have a great impact on meeting the UN sustainable development goals. The developed project of this group can become a platform to ensure the rights, justice and capabilities of different nations that have space ambitions and would help to envision its development so that the whole humanity is represented in space. It works on developing the list of human rights in space, provision of sustainability and ethics in space (Ethics, 2021).

The development of the Declaration of Human Rights in Space should be based on the following principles:

1. A commitment to the rights of all humans and respect for the moral standing of the living creatures and systems with whom we share our planet;
2. A commitment to a non-exploitative relationship with the Earth, space, and any potential non-Earth life-forms for the sake of scientific and peaceful collaborative exploration;
3. A commitment to non-proliferation of war or conflict on Earth or in space, and critical engagement with any potential partners whose activities expand or worsen conflict;
4. A recognition of the priority of Earthly processes over space ones;
5. A commitment to the recognition of space exploration as fundamentally nested within, and driven by, dominant political and socio-economic power-relations on Earth and the need to embed efforts to advance ethical space activities with their rightful social contexts (Ethics, 2021).

Conclusions

Human development is closely tightened with two basic factors: (1) genetic heredity and (2) public and legal reality. They are constantly developing, although the latter one is much more dynamic. The dynamics of heredity are governed by the million years of evolution with rare mutation that steadily changes the original biology. The public and legal reality also follows the evolutionary path but with a much greater rate of revolutionary changes.

We observe the social revolution of human transition from the Earth creature to the Space creature in modern times. The evolution of the human physical bodies happens much slower. Therefore, the issue of the protection of human rights of life and health of envoys of mankind

become the leading factor influencing the development of national and international space law. Especially since certain nations and private space companies have mid-term plans to send human missions to Mars.

Thus, to portray and solve the identified problems of long-lasting space missions and to prevent the violation of human rights of life and health of envoys of mankind we have suggested changes for the international space law. It could be implemented in the UN's Declaration on Human Rights in Space as a fundamental international space legal document that would influence national space legislation on long-lasting space missions.

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Artemis Accords and the Future of Space Governance: Intentions and Reality

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The article is devoted to the study of the leading positions and principles of Artemis. We are going to consider 13 provisions, including purpose and scope, implementation, peaceful purposes, transparency, interoperability, emergency assistance, registration of space objects, publication of scientific data, preservation of space heritage, space resources, space de-conflict. Actions, Orbital Debris, and Final Provisions. The article opted for exploratory research using an open, grounded theory approach, including regulations, abstracts of international conferences. The data was supplemented by legal documents, including materials from laws, acts and contracts. In this article, we will learn about the leading role of the Artemis Agreement for the signatory countries and why further agreements between the signatories and the United States are so important. The article explores the principle of adaptive management, which began to develop rapidly thanks to Artemis Accords, and its implications for international cooperation. The use of space resources in terms of the Artemis Agreement is also being analyzed, as today we see some differences between the provisions on innovation of the Artemis Agreement and the Outer Space Treaty. This article examines the compliance of Artemis Accords with international law and international standards, as its main purpose is to confirm the willingness of the signatory countries to work together on the basis of established principles.

Keywords: Artemis Agreement, United Nations Office for Outer Space Affairs, European Space Agency, NASA, Outer Space Treaty, Moon Agreement, exploitation of natural resources.

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Introduction

Artemis is a NASA program in cooperation with private companies and space agencies, including the European one, for the development of manned space flights. This program was named after the eponymous U.S. lunar exploration program. The main objectives of such a program are to establish and implement a form of basic principles of research and economic activity in outer space, implement the provisions of the Outer Space Treaty and other relevant international instruments and thereby establish a political understanding regarding mutually beneficial practices for future exploration and use of outer space, with a focus on activities conducted in support of the Artemis Program. The program operates based on agreements on the principles of cooperation in public research and the use of the Moon, Mars, comets, and asteroids for peaceful purposes. The Artemis Accords are part of the Artemis Program led by the U.S. National Aeronautics and Space Administration (NASA). A distinctive trait of the Artemis Program is that it envisages the construction of a permanent outpost on the Moon, which includes a dedicated orbital station (the lunar "Gateway") and a self-sustaining lunar base (the Moon Base Camp). To implement the Artemis Program, NASA is seeking the international collaboration of States and commercial partners. To that intention, it has elaborated a set of guidelines that will form an integral part of any subsequent agreement with international partners. In practice, states wishing to enter into collaboration with NASA must commit in advance to abide by the principles outlined in the Artemis Accords (Deplano, 2021).

Artemis Accords were signed on 13 October 2020 at the 71st International Congress of Astronautics by the following countries: USA, Australia, Canada, Japan, Luxembourg, Italy, Great Britain, and the United Arab Emirates (Artemis, 2020). One month later, Ukraine joined them (Ukraine, 2020). As of June 2021, 12 countries have embraced the Artemis Accords: Australia, Brazil, Canada, Italy, Japan, Luxembourg, New Zealand, the Republic of Korea, Ukraine, the United Arab Emirates, the United Kingdom, and the United States (International, 2021). On 22 October 2020, a webinar was held on the topic "The Artemis Accords and the Future of Space Governance: Volume II" (Artemis Accords, 2020).

Melissa de Zwart notes that the Artemis project will rely heavily on the involvement of commercial space operators, and other states are invited to become part of the project through relevant space agencies. However, participation depends on the adoption and adherence to the Artemis Agreements, reflecting "a shared vision of the principles based on the 1967 Outer Space Treaty to create a safe and transparent environment conducive to exploration, science, and business for all mankind to enjoy". Melissa de Zwart writes that the principles underlying the Artemis Agreements are crucial in the context of international space law, in particular the rules applicable to the use of space resources and territoriality, through the application of the contested "zone" principle. Artemis agreements are an important step forward in international space rights (de Zwart, 2021).

The normative character of the Artemis Accords

Artemis Accords affirming the importance of compliance with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, opened for signature on 27 January 1967 (Treaty, 1967) as well as the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, opened for signature on 22 April 1968 (Agreement, 1968), the Convention on International Liability for Damage Caused by Space Objects, opened

for signature on 29 March 1972 (Convention, 1972), and the Convention on Registration of Objects Launched into Outer Space, opened for signature on 14 January 1975 (Registration, 1975); as well as the benefits of coordination via multilateral forums, such as the United Nations Committee on the Peaceful Uses of Outer Space (Committee, 2020), to further efforts toward a global consensus on critical issues regarding space exploration and use.

Paragraph 2 of Section 13 "Final Provisions" states that the government of the United States of America will maintain the original text of Artemis Accords and transmit to the Secretary-General of the United Nations a copy of these Accords, which is not eligible for registration under Article 102 of the Charter of the United Nations, with a view to its circulation to all the members of the Organization as an official document of the United Nations. This provision means that the Agreement will not be registered following paragraph 1 of Article 102 of the UN Charter. Therefore, none of the parties to the Agreement will be able to refer to it in any of the U.N. bodies. Thus, the United States does not entrust the U.N. with the functions of the depositary of the Agreement. This fundamentally distinguishes the Artemis Agreement from the four main international legal acts on which the space powers of the world are guided in their activities. These are the Space Treaty, the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968), the Convention on International Liability for Damage Caused by Space Objects (1972), the Convention on the Registration of Objects Launched into space (1975). The depository of all four documents is the U.N. However, in the case of the Artemis Agreement, the United States, as the depositary, will keep the original texts of the agreements, verify that all signatures, documents, and notices related to the Agreement are in order, and inform the states that have the right to become parties to the Agreement.

The guiding principles of the Artemis program are peaceful activities, transparency, interoperability (functional interaction), emergency assistance, spacecraft registration, publication of scientific data, preservation of space heritage, extraction of space resources, conflict prevention, and counteraction to the formation of space. The Artemis Agreement does not contain a reference to the Agreement on the Activities of States on the Moon and Other Celestial Bodies (1984), as the United States did not sign. However, on 6 April 2020, Donald Trump signed the order to support the commercial extraction of resources on the Moon and other celestial bodies. The U.S. position on the possibility of appropriating space resources is constant and unchanging, and the United States seeks to extend this approach to other countries (Wall, 2020).

The structure and content of the Agreement is a protocol of intent. This is evidenced by the absence of essential terms of the contract: the distribution of responsibilities of the parties, the specific subject of the contract, the term of the contract, the order of transfer or distribution of results, financial obligations of the parties, intellectual property rights to objects manufactured during the contract, responsibilities of the parties and the procedure for resolving disputes and others.

Section 1, "Purpose and Scope," states that the purpose of these Accords is to establish a common vision via a practical set of principles, guidelines, and best practices to enhance the governance of the civil exploration and use of outer space to advance the Artemis Program. Adherence to a practical set of principles, guidelines, and best practices in carrying out activities in outer space is intended to increase the safety of operations, reduce uncertainty, and promote the sustainable and beneficial use of space for all humankind. Section 2 – Implementation means that cooperative activities regarding the exploration and use of outer space may be

implemented through appropriate instruments, such as Memoranda of Understanding, Implementing Arrangements under existing Government-to-Government Agreements, Agency-to-Agency arrangements, or other instruments. Section 3 – Peaceful Purposes means that the signatories affirm that cooperative activities under these Accords should be exclusively for peaceful purposes and follow relevant international law. International cooperation on Artemis is intended not only to bolster space exploration but to enhance peaceful relationships between nations. Therefore, at the core of the Artemis Accords is the requirement that all activities will be conducted for peaceful purposes, per the tenets of the Outer Space Treaty. Per Section 4 – Transparency, the Signatories are committed to transparency in the broad dissemination of information regarding their national space policies and space exploration plans under their national rules and regulations. Transparency is a key principle for responsible public space exploration and NASA has always taken care to publicly describe its policies and plans. Artemis Accords partner nations will be required to uphold this principle by publicly transparently describing their policies and plans. Interoperability of systems is critical to ensure safe and robust space exploration. Therefore, the Artemis Accords call for partner nations to utilize open international standards, develop new standards when necessary, and strive to support interoperability to the greatest extent practical. Section 5 Interoperability states that the signatories recognize that the development of interoperable and common exploration infrastructure and standards, including but not limited to fuel storage and delivery systems, landing structures, communications systems, and power systems, will enhance space-based exploration, scientific discovery, and commercial utilization. The Signatories commit to using reasonable efforts to utilize current interoperability standards for space-based infrastructure, to establish such standards when current standards do not exist or are inadequate, and to follow such standards. Providing emergency assistance to those in need is a cornerstone of any responsible civil space program. Therefore, the Artemis Accords reaffirm NASA's and partner nations' commitments to the Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space. Additionally, under the Accords, NASA and partner nations commit to taking all reasonable steps to assist astronauts in distress. Section 6 – Emergency Assistance states that the signatories commit to taking all reasonable efforts to render necessary assistance to personnel in outer space who are in distress and acknowledge their obligations under the Rescue and Return Agreement. The issue concerning the registration of space objects is highlighted in Section 7. This section states that for cooperative activities under these Accords, the Signatories commit to determine which of them should register any relevant space object following the Registration Convention. For activities involving a non-Party to the Registration Convention, the Signatories intend to cooperate to consult with that non-Party to determine the appropriate means of registration. Registration is at the core of creating a safe and sustainable environment in space to conduct public and private activities. Without proper registration, coordination to avoid harmful interference cannot take place. The Artemis Accords reinforce the critical nature of registration and urge any partner who is not already a member of the Registration Convention to join as soon as possible. NASA has always been committed to the timely, full, and open sharing of scientific data. Artemis Accords partners will agree to follow NASA's example, releasing their scientific data publicly to ensure that the entire world can benefit from the Artemis journey of exploration and discovery. Section 8 – Release of Scientific Data states that signatories reserve the right to report and publish information to the public on their activities. Signatories must coordinate with each other in advance on the public disclosure of information concerning other

signatories' activities, and signatories must openly exchange scientific data. However, such obligations regarding the open exchange of scientific data do not apply to the private sector, unless such transactions are conducted on behalf of a Signatory to the Agreements. Therefore, Section 8 stipulates that open data sharing obligations do not apply to private sector activities unless such transactions are conducted on behalf of a party to the Agreement. The Agreement does not prevent the signatory states from involving private entities in fulfilling the terms of further agreements. On the one hand, the Agreement does not contain direct bans on attraction, and on the other hand, the United States is the flagship of space activities at the national level based on public-private partnership. Therefore, by opening the Artemis Agreement for signing, the United States is trying to show its counterparts the urgency and economic justification. The United States has already involved several private companies in the Artemis Program, such as Blue Origin, Dynetics, Lockheed Martin, and SpaceX. Protecting historical sites and artifacts will be just as important in space as it is here on Earth. Therefore, under Artemis Accords agreements, NASA and partner nations will commit to the protection of sites and artifacts with historic value According to Section 9 – Preserving outer space heritage. The signatories intend to preserve the space heritage, which they believe includes historically significant human or robotic landing sites, artifacts, spacecraft, and other evidence of activity on celestial bodies following mutually developed standards and practices. The signatories to the Convention intend to use their experience under the Agreements to promote multilateral efforts to further develop international practices and rules applicable to the preservation of space heritage (Artemis, 2020).

We should admit that in the Outer Space Treaty, there is no provision under which the concept of space heritage neatly falls. The closest provision is Article 7, paragraph 3, of the Moon Agreement. It reads: "States Parties shall report to other States Parties and to the Secretary-General concerning areas of the Moon having a special scientific interest so that, without prejudice to the rights of the other States Parties, consideration may be given to the designation of such areas as international scientific preserves for which special protective arrangements are to be agreed upon in consultation with the competent bodies of the United Nations" (Agreement, 1984). It should be understood that in the case of the creation of international scientific reserves does not violate the principle of free research and use of celestial bodies, then the creation of international historical and cultural reserves is carried out by analogy. According to Clause 2 of Section 9 of the Artemis Agreements, the signatory states must work to preserve the heritage, which in practice involves the creation of a security zone. It should be noted that the main difference between the creation of a safety zone to facilitate the use of natural resources of celestial bodies and the creation of a safety zone to protect human heritage in space is that the latter will create a zone of deconfliction to prevent damage to landings and idle facilities. such as artifacts, not people (Agreement, 1984).

The issue of space resources is highlighted in Section 10. Vladymir Tolstykh has noted that in the past few years, the situation related to the exploration and use of space had changed dramatically and it had been proven that the extraction of space resources could be profitable; there was a gap between the state of the space industry in the United States and other countries. These changes resulted in a US-initiated reform aimed at legalizing the appropriation of extracted space resources, as well as, in the long term, at legalizing the appropriation of sites of celestial bodies and resources in situ by both individuals and states. Its instruments are proposals for the reinterpretation of key agreements, new U.S. and Luxembourg law and the Artemis Accords signed on 13 October 2020. As a result, we can talk about the emergence

of an international custom that legalizes the appropriation of extracted resources (Tolstykh, 2021).

Accordingly with block 5 of Building Blocks for the Development of an International Framework on Space Resource Activities states bear international responsibility for national space resource activities, whether such activities are carried out by governmental agencies or non-governmental entities, and for ensuring that such activities are carried out in conformity with the international framework; non-governmental space resource activities shall require prior authorization and continuing supervision by the appropriate State; when space resource activities are carried out by an international organization, responsibility for compliance with the international framework shall be borne by the international organization and by the States participating in such organization. Block 8 highlights the main provisions concerning resource rights. Following this block, the international framework should ensure that resource rights over raw mineral and volatile materials extracted from space resources, as well as products derived therefrom, can lawfully be acquired through domestic legislation, bilateral agreements, and/or multilateral agreements. Also, the international framework should enable the mutual recognition between States of such resource rights. The international legal framework should ensure that the utilization of space resources is carried out under the principle of non-appropriation under Article II OST1 (Building, 2019).

Per the Artemis Accords, the signatories note that the use of space resources can benefit humanity by providing critical support for safe and sustainable operations. The Signatories emphasize that the extraction and use of space resources, including any recovery from the surface or underground surface of the Moon, Mars, comets, or asteroids, should be carried out in a manner consistent with the Outer Space Treaty and support of safe and sustainable space activities. The Signatories affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty and that contracts and other legal instruments relating to space resources should be consistent with that Treaty. The Signatories commit to informing the Secretary-General of the United Nations as well as the public and international scientific community of their space resource extraction activities per the Outer Space Treaty. The Signatories intend to use their experience under the Accords to contribute to multilateral efforts to further develop international practices and rules applicable to the extraction and utilization of space resources, including through ongoing efforts at the COPUOS. Interestingly, neither the Artemis Agreement nor the Outer Space Treaty contains direct prohibitions on the establishment of ownership of space resources. This means that the general recognition by all signatories of the legality of exploitation and subsequent recognition of the right of ownership of space resources is a kind of legal precondition for participation in the Artemis Program. It is noteworthy that the three signatory states to the Agreement have settled in advance the issue of commercial extraction of minerals on celestial bodies. These are the United States (U.S, 2015), Luxembourg (Loi, 2017), and the UAE (Law, 2019). It should be noted that Australia is currently the only signatory to the Artemis Agreement, which is also a signatory to the Agreement on the Activities of States on the Moon and Other Celestial Bodies (Agreement, 1979). St. Article 11 of this Agreement establishes that the Moon and its natural resources are the common heritage of mankind and that the Moon‘s subsoil, parts of its surface or subsoil or natural resources, where they are located, may not be owned by any State, international intergovernmental or non-governmental organization, national organization or non-governmental institution or any individual.

Avoiding harmful interference is an important principle of the Outer Space Treaty which is implemented by the Artemis Accords.

Section 11 Deconfliction of Space Activities, in our opinion, is quite contradictory. We should admit that the concept of a safety zone is not mentioned in the Outer Space Treaty, and its introduction in Section 11 of the Artemis Accords represents a genuine innovation. According to Section 11, the Signatories affirm that the exploration and use of outer space should be conducted with due consideration to the United Nations Guidelines for the Long-term Sustainability of Outer Space Activities adopted by the COPUOS in 2019, with appropriate changes to reflect the nature of operations beyond low-Earth orbit. Following Article IX of the Outer Space Treaty, a Signatory authorizing activities under these Agreements must adhere to the principle of due diligence. The Signatories shall not have the right to engage in activities that could adversely interfere with the use of outer space in the activities of the other Party. The activity of one party is related to the activity of the other party. To fulfill their obligations under the Outer Space Treaty, the Parties shall submit information on their activities and coordinate with the relevant entity to avoid harmful interference. The area in which this communication and coordination will be implemented to avoid harmful interference is called the "safety zone." Specifically, via the Artemis Accords, NASA and partner nations will provide public information regarding the location and general nature of operations which will inform the scale and scope of "Safety Zones." The safety zone must be the zone in which the initial operations of the activity concerned or the abnormal event may reasonably cause harmful interference. During their activities, signatories must adhere to certain rules of this security zone, namely: the size and scope of the security zone must reflect the nature of the operations carried out, must be determined reasonably in the light of engineering and scientific principles. In the event of a change like the activity, the size and scope of the relevant security zone should change. The signatory during the creation, maintenance, or completion of the security zone must do so in such a way as to protect public and private personnel, equipment from harmful interference. Notification and coordination between partner nations to respect such safety zones will prevent harmful interference, implementing Article IX of the Outer Space Treaty and reinforcing the principle of due regard.

However, the question arises whether the security zones will not turn into attempts to establish national sovereignty on celestial bodies or their occupation, which is prohibited by Art. 2 of the Space Treaty. After all, in practice, there may be a situation where Entity 1 establishes an appropriate security zone in a part of a celestial body, in which case the free access of Entity 2 to that part may be regarded by Entity 1 as a harmful interference with its use of outer space. At the same time, Entity 1 can, in practice, engage in space activities in the same area of the celestial body for a long time, building the necessary infrastructure for the life and work of its personnel. The time for space activities is not set. Thus, if during this period the legislation on the Earth changes and the Space Treaty in certain circumstances loses force or the corresponding changes will be made to it, Entity 1 can get the property rights to the constructions and buildings located there, without acquiring at this ownership of the land beneath them (Richards, 2017).

In 2016, such a concept was discussed by the Hague Working Group on Space Resources Management. As a result, in 2019, the Building Blocks for the Development of an International Framework on Space Resource Activities were developed and agreed upon. According to these developments, it is not legitimate to double-interpret the very concept of "security zones" and the obligations to operate in them, the requirements for

security measures in such zones (block 11.3), and appropriate international consultations on their establishment (block 11.4) should be appropriate level (Building, 2019).

The issue concerning orbital debris is highlighted in Section 12. Preserving a safe and sustainable environment in space is critical for both public and private activities. NASA and partner nations will agree to plan for the mitigation of orbital debris, including the safe, timely, and efficient passivation and disposal of spacecraft at the end of their missions. The Signatories commit to planning for the mitigation of orbital debris, including the safe, timely, and efficient passivation and disposal of spacecraft at the end of their missions, when appropriate, as part of their mission planning process. In the case of cooperative missions, such plans should explicitly include which Signatory has the primary responsibility for the end-of-mission planning and implementation. The Signatories commit to limit, to the extent practicable, the generation of new, long-lived harmful debris released through normal operations, break-up in operational or post-mission 7 phases, and accidents and conjunctions, by taking appropriate measures such as the selection of safe flight profiles and operational configurations as well as post-mission disposal of space structures (Artemis, 2020).

Section 13 includes Final Provisions, which means that building on any consultative mechanisms in preexisting arrangements as appropriate, the Signatories commit to periodically consult to review the implementation of the principles in Accords, and to exchange views on potential areas of future cooperation (Artemis, 2020).

For the sake of exposition, the provisions of the Artemis Accords can be grouped into three categories. The first category simply transposes provisions of the Outer Space Treaty into the text of the Artemis Accords. The second category implements provisions of the Outer Space Treaty, adding detail and clarity to the rights and obligations contained therein. The third category introduces new concepts. The explicit commitment of the signatories to operate within the boundaries of the Outer Space Treaty's principles makes the content of the Artemis Accords relatively uncontentious. However, closer scrutiny reveals that certain provisions of the Artemis Accords go a step further than mere implementation, effectively introducing concepts and principles not mentioned in the Outer Space Treaty, thus raising issues of compatibility (Deplano, 2021).

Rossana Deplano divided the provisions of the Artemis Accords into three types. The first type includes verbatim transpositions of provisions of the Outer Space Treaty into the text of the Artemis Accords. For instance, Section 3 of the Artemis Accords states that any activity carried out by the signatories shall be exclusively for peaceful purposes, thus replicating the provision contained in article IV, paragraph 2, of the Outer Space Treaty2. The second type consists of provisions that cite articles of the Outer SpaceTreaty instead of replicating their content. For example, Section 4 of the Artemis Accords requires the signatory States to share scientific information resulting from their space activities with the public and the scientific community on a good faith basis and consistent with Article XI of the Outer Space Treaty – that is to say, providing the details of the nature, conduct, and locations of such activities (Deplano, 2021).

The third type includes provisions of the Artemis Accords loosely related to the text of the Outer Space Treaty but grounded on international law instruments. For example, Section 4 of the Artemis Accords requires the signatory States to adopt standards that will ensure the interoperability of any infrastructure used for space-based exploration. The provision reflects established practice in the field of international cooperation in outer space, dating back to the historic docking of the joint Apollo-Soyuz mission in 1975 (Deplano, 2021).

In our opinion, the advantage of the Artemis agreement is the spread beyond the United States of the already successful scenario of public-private partnership in space activities, promoting the commercialization of such activities by involving international partners and private entities. It is the United States that is responsible for building new diplomatic bridges between the states that have been engaged in space activities only recently, as well as those states that have previously had no precedent for interaction with each other in the space sector. The signing of the Artemis Agreement is important for the signatory countries due to further cooperation in the study and use of outer space for peaceful purposes.

An interesting question is whether the signatories agree to be bound by the Agreement. For example, following paragraph 1 of Art. 9 of the Constitution of Ukraine, part of the national legislation of Ukraine are those international treaties, the binding nature of which was approved by the Verkhovna Rada of Ukraine. At the same time, paragraph 2 of Article 9 of the Law of Ukraine "On International Treaties of Ukraine" stipulates that political treaties are subject to ratification in particular. In this context, it should be recalled: Section 1 of the Agreement itself declares that accession to the Agreement constitutes a political commitment to the principles described therein, and Section 13 does not provide direct guidance on how States may agree to be bound by the Agreement, in addition to the actual indication of the accession mechanism in the form of a signature in addition to the text of the U.S. Government Agreement.

Conclusion

Accession to the Artemis Accords is a significant step for the signatory countries, which allows them to fully demonstrate all the accumulated technical potential. Further agreements, which will be concluded between the two parties and will clearly define their rights and obligations in the framework of such cooperation, will be crucial for cooperation between the signatories and the United States in the deep space program. As for the role of the Artemis Accords in establishing relations between space powers, its main purpose is to confirm the readiness of contractors to joint activities based on the principles set out in the Agreement.

The Artemis Accords are not binding in nature, but the overriding goal is to ensure top priorities in space activities. The Artemis Accords took into account the obligations of the Outer Space Treaty, as it is an international basis for cooperation. It should be noted that the Artemis Accords provide a starting point for further discussion of the international framework for space activities, as they encourage and facilitate the fulfillment of space commitments. Important in the study of Artemis agreements is that they are fully developing the principle of adaptive governance, which is extremely important today for international cooperation.

The issue of space exploitation is becoming important today, and this process is gaining in importance and becoming inevitable, contrary to the provisions of the Moon Agreement of 1979. Therefore, provisions of the Artemis Accords are innovative, moving towards development issues of space resources exploitation, but need further improvement.

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Scientific and Technological Development, Technological Systems, Innovations and Their Importance for Space Sector of Ukraine

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The achievements of scientific and technological development of the space sector can be used only if adequate basic conditions for such development are provided, first of all, its proper and effective legal regulatory framework. The dialectical method enables to study processes of science and technology convergence of in the space sector. The scientific novelty is that the concept of technological systems is used as a theoretical basis for changing the emphasis from "scientific and technical" to "scientific and technological" development, which is historically justified. On the basis of the specified concept priority trends in the scientific and technological development of the space sector of Ukraine are listed. It is concluded that scientific and technological development in the space sector as a result of a new scientific and technological paradigm is a multifaceted phenomenon, proposed to be considered as 1) a complex multi-vector phenomenon and the highest socio-cultural value in the development of mankind; 2) direct causal relation with sustainable and inclusive development, general well-being and social progress in general; 3) an intensive factor influencing economic growth, competitiveness and national security of the state.

Keywords: space sector, scientific and technological development, globalization, technological revolution, paradigm, technological system, public administration, legal regulatory framework, innovations.

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Introduction

According to representatives of various scientific perspectives, the current stage of development of society and civilization is described as a "knowledge society" (David, 2003), "third wave society" (Collins et al., 2010), "the fourth technological revolution" (Prisecaru, 2016), "Industry 4.0" (Lasi et al., 2014). New phenomena and concepts emerge: technoscience (Law & Mol, 2001), cognitive science, NBIC technology (nano-bio-info-cogno) (Managing, 2006), CALS technology (Continuous Acquisition and Life cycle Support) (Rigby, 1996), High-Tech, High-Human, etc. Science and technology have a very fast pace of development, the time limits of the formation of technological systems are reduced, which indicates profound changes in society.

Despite the terminological differences of new concepts, it is all about the implementation of scientific and technological advances into socio-economic practice that enable to reduce the negative effects of existing socio-economic and environmental problems, avoid new ones, ensure a sustainable future for future generations. The above is confirmed by the "2030 Agenda for Sustainable Development" adopted by the UN General Assembly in 2015 (Take, 2021). There, for the first time, the role of science and technology is highly recognized as the most important factor in ensuring inclusive, sustainable development. This is due to the ability of States to mobilize existing opportunities, adapt to new globalization changes, to form new legal, managerial, organizational, financial approaches and tools of influence in the "permanent" technological revolution.

Therefore, a positive effect from the use of the scientific and technological achievements in the space sector can be only if adequate basic conditions for such development are provided, first of all, its proper and effective legal regulatory framework.

Analysis of Ukraine's status in the global scientific and technological space is presented in international rankings and indices. They enable to assess objectively the scientific and technological potential, scientific, technological and innovative competitiveness of the state according to various social, economic and institutional indicators, including in the space sector. For example, the Global Innovation Index, published annually by the World Intellectual Property Organization, Cornell University and the Business School for the World INSEAD, assesses the elements of national economies in which innovation processes take place. For example, according to GII in 2020, Ukraine was ranked as the 45th out of 131 countries, receiving an index of 36.3 out of 100 possible for all indicators (in 2019, Ukraine was ranked as the 47th out of 129 countries with an index of 37.4 points; in 2018, the 43rd place among 126 countries with an index of 38.5 points) (Global Innovation, 2020). According to the Bloomberg Innovation Index, which uses indicators such as R&D intensity, manufacturing capability, technology company density, research concentration, value-added production, tertiary education and patent activity, in 2020, Ukraine was ranked as the 56th out of 60 with a total score of 53 (in 2019, the 53rd place with a total score of 48; in 2018, the 46th place with a total score of 42) (The Bloomberg, 2020). According to the 2020 Innovation Union Scoreboard Report, in 2019, Ukraine was classified as a country of "slow innovators" with a cumulative index of 32.9% (24.7% in 2018). According to the Global Competitiveness Index, which is calculated according to the methodology of the World Economic Forum and has, in particular, benchmarks such as higher education and training, level of technological development and innovation potential, Ukraine in 2019 was ranked as the 85th out of 141 participants (the 83rd place out of 140 participants in 2018) (Global Competitiveness, 2020).

These data indicate that the current model of public administration in Ukraine in the field of scientific and technological development in the space sector is inefficient. In addition to disabling the economic growth of the state, its competitiveness in the world market, it also poses real threats to Ukraine's national security. This has been repeatedly confirmed by national parliamentary hearings on problematic issues in the field of science (On the State, 2016), technology, innovation and space activities (On the Establishment, 2021).

In turn, science-intensive industries, such as rocketry, are major producers of new technologies and promoters of higher technological levels in the country. Moreover, the high-tech sector can help advance new technologies to less advanced sectors of the economy. It contributes to creating new jobs faster and at a lower cost, to economic development and growth (Scientific, 2001). For example, the famous analyst E. Mazareanu's report predicts that the global space economy will reach 1.1 trillion dollars by 2040, and the share of government spending in the global space economy will decrease from 25 to 17% (Mazareanu, 2019). To sum up, it should be emphasized that the sustainable scientific and technological development of space activities requires combining all available legal, financial, organizational mechanisms and using the opportunities of both public and private sectors.

In addition, the lack of comprehensive monographic studies considering scientific and technological development in the space sector as an object of the legal regulatory framework and a direct subject of scientific research; the presence of systemic problems of scientific and technological development in the space sector of Ukraine; the need to form a conceptually new model of the legal regulatory framework, taking into account global trends, global challenges and the commercialization of space activities justify the relevance and timeliness of our study.

Conceptual approaches to the doctrinal understanding of the convergence of science and technology in the space sector

Recently, the world community has focused on scientific and technological development in general and in space in particular. The development of science and technology is considered by the world community as key factors of sustainable development, and although in today's world there are anti-scientific trends, but science is seen as the highest value of human culture and civilization. Moreover, the socio-economic indicators of the state are determined by a set of its new technologies. In this regard, scientific and technological development in the space sector is considered by most highly developed countries from the perspective of one of the key priorities of public policy.

In the context of globalization and the ever-accelerating technological changes in the space sector, the issues of convergence of science and technology are increasingly relevant. They require rethinking and reassessment. The qualitative technological changes taking place in the world and the accelerated speed of such processes require not only individual States but also the world community to form new concepts of scientific and technological development in the space sector, based on the renewed role of States in these processes.

Nowadays, the technological role of science is particularly apparent due to active specific qualities of modern science – a new paradigm of science is being formed, we see fluctuations, evolution, complexity, diversity, interdisciplinarity and trans-disciplinarity. In addition, all these qualities, characteristics of modern science are manifested not only at the macroscopic level, for example, in chemistry, but also at the microscopic level, in particle physics, and on a cosmic scale, in modern cosmology. Finally, modern science is developing into a "knowledge

society." The "knowledge society" is characterized by profound changes in society itself, for which new scientific knowledge and technology become the dominant of existence, the basis of society as an information society. Moreover, one of the specificities of modern science is the diversity of new technologies, contributing to the process of technologizing of society (Moiseeva & Andreeva, 2013).

There are several conceptual approaches to the convergence of science and technology from the perspective of philosophy of law, philosophy of science and technology, sociology, economy, such as civilization, technically stadial, paradigmatic and revolutionary. However, all the above theories have rather more in common than differ, generally in terminology and primarily due to being formed at different times – at different phases and stages of scientific and technological development, and, accordingly, each reflects the features of that time.

One of the cognitive tools that allow not only to understand the problems of modern society, but also to construct the future, as it is immanent in the present, is the paradigm of scientific and technological development, which allows to consider scientific and technological development in the space sector through the mechanism of historical paradigm shift (Shevchenko, 2012).

The concept of changing scientific paradigms was developed by the American historian of science Thomas Kuhn. He presents the development of science as an abrupt revolutionary process, the essence of which is expressed in the change of paradigms. Thomas Kuhn argues: "A paradigm is a universally recognizable scientific achievement that, for a time, provides model problems and solutions to a community of practitioners" (Ruzavin, 2012). According to Thomas Kuhn, these models give rise to specific traditions of one or another trend in the study. Paradigms have both cognitive and regulatory functions. They give scientists the basic principles of their cognitive activity and forms of implementation of these principles (Skutina, 2017).

According to Thomas Kuhn, science in its development undergoes a number of periods: pre-paradigmatic (when there are several scientific schools, several different theories about the same thing), the period of normal science (when all scientific schools adopt a common theory as a paradigm), the period of uncertainty and crisis (when scientific facts contradictory to paradigms occur), which ends in some cases with a scientific revolution (Kuhn, 1996). At the same time, the revolution in science is subject to the following scheme: first, there is an awareness of "anomalies," i.e., the fact that the "paradigm" cannot cope with specific problems that arise in the development of "normal" science; then, to overcome the anomalies, numerous attempts are made to cosmetically "repair" the old paradigm, which, in case of failure, leads to a crisis situation where the anomalous fact can no longer be explained from the old paradigm, and solving the "puzzle problem" does not save the old theory. As a result, the old paradigm is replaced (Kondrakov, 2009).

In the development of science, there are turning points, crises, state of the art in knowledge, which radically change the former worldview (Perez, 2010). These turning points in the genesis of scientific knowledge have been called scientific revolutions (Golubintsev et al., 2008). In work "Scientific Revolution" (Dear & Sheipin 2015), S. Shapin argues that O. Koyré in 1939 has made the concept of "scientific revolution" common, although in the 1930's the French philosopher G. Bashlyar spoke of "mutations" in science (i.e., a high degree of discontinuity) (Khmelevskaya, 2017). The term "Scientific Revolution" became widespread in the 1950s, especially after the publications of "Scientific Revolution" (Hall, 1954) by A. Hall and of works by J. Bernal (one of the volumes of his "Historical Science" was called "Scientific and Industrial Revolutions" (Bernal, 2010)).

Next, some interpretations of the term "Scientific Revolution" come: Thomas Kuhn: "Scientific revolution is a noncumulative developmental episode in which an older paradigm is replaced in whole or in part by an incompatible new one" (Kuhn, 1996); I. Lakatos: "the scientific revolution is the fact of change of scientific (first of all, fundamental) theories, which are considered through the prism of its logical-methodological (rational) reconstruction, but not an event of real history and culture" (Lakatos, 2008). E. Agazzi: "Revolution is occurrence of a new form of knowledge" (Agazzi, 2017). P. Duem: "The independence of scientific revolutions is not obvious; it is a continuation of progressive trends in society" (Duhem, 1991; Khmelevskaya, 2017).

It should be noted that historically, the development of science differed from the development of technology. They were formed independently and separately; to some extent, even in isolation, scientific and technological revolutions did not coincide. In the middle of the 20th century, on the one hand, science began to interact closely with other spheres of life, and on the other, the number of new technologies increased, as well as the pace of their development and implementation based on the development of scientific knowledge. This process contributes to the gradual strengthening of the relationship between science and technology, is their synthesis. Accordingly, the process of scientific and technological convergence began, leading to a new phenomenon – the scientific and technological revolution (Kurkova, 2020).

To sum up, the technicalization of society and nature dates back to the agrarian revolution. However, such pre-industrial technologies were the result of trial and error, i.e., reflected practical experience, but not objective knowledge based on scientific results. In this way, the development of technology is directly related and is due primarily to the development of science.

With regard to the correlation between the terms "scientific and technical" and "scientific and technological" development, it should be noted that in different sources, the words "technology" and "technical" are used very ambiguously.

For example, the word "technology" comes from two Greek words, transliterated "techne" and "logos." "Techne" means an art, skill, craft, method, or means by which a thing is acquired. "Logos" means a word, utterance, through which the inner thought, utterance, or expression is conveyed. Therefore, literally, technology means words or reasoning about how to achieve something (Technology , 2021). Therefore, in some cases it refers to state of the art in technology at some stage of social development, in others, to the method of production of any product, as well as to the industry that manufactures these products, and even to the product itself without a clear distinction between these tree options (Avdulov & Kulkin 2010; Technology, 2021).

In turn, the word "technical" also comes from the Greek word "technikós," that is, an art and crafts. It is equivalent to téchn (ē) + -ikos-ic (adj.) (Technic, 2021). Therefore, in many English dictionaries, the phrases "scientific and technical development" and "scientific and technological" have a similar interpretation (What, 2021) and are synonyms. However, in our opinion, scientific and technical development is an element of scientific and technological development, which has a broader interpretation. This is because, in essence, technology is what allows scientific knowledge to be applied in practice. This is a set of tools, methods, techniques, which is lined up in a logical chain, a protocol of actions in order to achieve the desired result.

To sum up, the development of science, technics and technology, their gradual synthesis led to a new phenomenon in the first half of the 20th century – a scientific and technological

revolution, which gradually, in the course of the change of technological systems has transformed first to the scientific and technological revolution, and overtime to a renewed phenomenon – scientific and technological convergence.

The preconditions for this phenomenon were the two World Wars, which affected the nature and pace of scientific and technological development in general and in the space sector in particular. These events led to the realization of the role of the scientific and technological potential of the country and the need for State regulation of its development, including the need to increase funding for science in space.

Despite the fact that scientific and technological development in the space sector has been and is more defensive in nature, it was aimed primarily at military needs. This process contributed to the overall acceleration of science. Later, the scientific results of the military industry began to be implemented for peaceful purposes. Therefore, rivalry in space forced States to intervene more actively in economic, scientific and technological development, which contributed to the rapid development of science and technology. As a result, the current situation in the world has forced States to accept the need for being active in the process of economic, social and, accordingly, scientific and technological development, as well as formed new priorities of public policy and public administration. Globalization and acceleration of scientific and technological development contributed to the fact that in the second half of the 20th century, issues of research and technological development in the space sector shifted from the national to the international level, began to form the foundations of international cooperation in this field.

Therefore, nowadays, we can observe a new scientific and technological paradigm: the convergence of science, technology and society as a cumulative result of previous scientific and technological revolutions, covering all sectors of social life and human life, including space.

The technological system of the country and its impact on the scientific and technological development of the space sector of Ukraine

It should be noted that an important pattern of global economic development is its irregularity, due to the periodic process of successive replacement of integrated complexes of technologically integrated industries – technological systems. In the context of scientific and technological progress, a new technological system is formed when the forms to combine means of labour, objects of labour and labour force in the process of production and services fundamentally change. At each stage of its development, society relies on a more perfect than the previous technological system (Sboychakova, 2010).

The beginning of the theory of economic cycle is in the works of Nikolay Kondratiev. His theory's heart is the hypothesis that the scientific and technical revolution is built in a wave-like manner by changing technological systems with cycles lasting 40-60 years (N.D. Kondratiev, 2017: 6). In his work, Nikolay Kondratiev writes about "increasing" and "lowering" waves, focusing on the fact that at the beginning of each cycle before the rapid growth of science and technology, there are profound changes in the economic life of society. These changes are manifested in such phenomena as radical modernization of technology, the involvement of new countries in world economic communications, changes in gold mining, money circulation. He stresses that scientific and technological innovations play an important role. Each such cycle ends with a systemic crisis, which is the transition of productive forces to a higher quality stage of development (Zagidullina & Sobolev, 2014).

I. Schumpeter advocates the theory of long waves. In his writings, he argues that it is an innovation that contributes to long waves of business activity. According to him, innovations are "a sign of the technological revolution and its results." He underlines that innovation in the economy creates a so-called "gale of creative destruction," which shatters the balance of the existing economic system, leads to the elimination of outdated technologies and organizational structures, creates new strong industries. The result of this "gale" is an exceptional growth of the economy and the population's well-being. I. Schumpeter presents innovation as a kind of catalyst for economic growth (Zagidullina & Sobolev, 2014; Schumpeter, 2008).

According to another group of scientists, the technological system should be understood as a set of technologies and industries of a single level, combined into a single integrated system of its industries, associated with flows of quality resources supported by the skilled labour force, general scientific and technical content (Zagidullina & Sobolev, 2014). Yu. Yakovets interprets the technological system as "several interdependent, successively replacing each other generations of technology, which evolutionarily implement the general technological principle" (Sboychakova, 2010; Yakovets, 2004). S. Hlaziev defines the technological system as a key factor, the core, the organizational, and economic regulatory mechanism. The core of the technological system is a set of basic technological processes that are actually used or are characteristic for a long time for sectors and branches of the economy, while material conditions for each new technological system are formed in the course of the previous one. The economy develops due to consistent changes in such systems (Sboychakova, 2010).

To sum up, the concept of technological systems is an effective tool for understanding the nature and patterns of scientific and technological development in the space sector. Therefore, in our opinion, the concept of technological systems makes sense to use as a theoretical basis for listing priority trends of scientific and technological development in the space sector of Ukraine.

The review of current perspectives enables to identify six technological systems (Kurkova, 2020).

The first technological system (1770-1830 – the first industrial revolution) is characterized by the development of the textile industry, the use of water energy, and as a result, factory production mechanization.

The second technological system (1830-1880) implies the development of the coal and metallurgical industries, railways, shipping based on steam engines.

The third technological system (1880-1930 – the second industrial revolution) implies the development of electrical and chemical industries (inorganic chemistry), heavy engineering (especially shipbuilding), the advent of radio and telecommunications, characterized by a concentration of banking and financial capital.

The fourth technological system (1930-1980 – the beginning of the scientific and technical revolution) implies the further development of energetics using oil (petroleum products), synthetic polymeric materials; chemical industry (organic chemistry); the beginning of the development of nuclear energy (both for military and peaceful purposes); widespread automotive, aircraft; developing electronics; computers and software products actively implemented; the beginning of rocketry and satellites; the beginning of mass production with the use of conveyor technologies; multinational and international companies actively investing capital.

The fifth technological system (1980-2020) is based on the achievements of computer science, microelectronics, genetic engineering, biotechnology, information and telecommunications

technologies, new types of energy, technopolis, technoparks, space exploration.

The sixth technological system (2010-2040) implies the development of nanotechnologies, photonics, optoelectronics, microsystem mechanics, molecular electronics, global information networks, artificial intelligence systems, information superhighways, Cals-Technologies (Continuous Acquisition and Life cycle Support), further development of the aerospace industry, the use of non-traditional energy sources.

Therefore, our study focuses only on the fourth, fifth, and sixth technological systems. Because in these systems, space technology has become the basic innovation and driving force of scientific and technological development.

It should be noted that today many scientists who study economic cycles recognize the importance of the formation of a new technological system. The outlines of this system arise in developed countries, such as the United States, Japan and the People's Republic of China; it is focused on the development and use of knowledge-intensive, i.e., "high technology." In the USA, the apportionment of this or that technological system is as follows: the fourth system makes 20%, the fifth is 60%, and about 5% belongs to the sixth system (Kablov, 2010). The United States was one of the first countries to enter the sixth technological system. The main prerequisites for this were a strong and stable political system, an effective mechanism for economic growth, scientific and technological progress (Zagidullina & Sobolev, 2014), as well as the promotion of national space activities.

With regard to Ukraine, economists argue (Fedorova, 2016; Bazhal, 2001; Dubyk & Osidach, 2014; Yerokhin, 2006) that today in Ukraine, there are mainly III and IV technological systems, and their total share is 95%. 58-60% of the output is accounted for by the third technological system, and 35-37% for the IV technological system (electricity and the use of oil and petroleum products as the main energy source; ferrous metallurgy; shipbuilding; light, woodworking, pulp and paper industries). The 5th technological system accounts for only 4-5%, and the 6th, the implementation of which determines the prospects for high-tech development of the country in the future – up to 0,1%.

The GDP growth due to the introduction of new technologies in Ukraine is estimated at only 0,7-1%, while in developed countries, this figure reaches 60% and even 90%. This situation is the result of errors in the transformation processes of the first years of independence (Dubyk & Osidach, 2014). According to the indicator of financing scientific and technical developments, the situation is as follows: today, almost 70% of funds are absorbed by the 4th and only 23% by the 5th technological systems. Innovation costs are distributed as follows: 60% for the 4th technological system and 30% for the 3rd (totally 90%), and the 5th is only 8,6%. With regard to investments, which, in fact, determine the future for the next 10-15 years, we have the following proportions: 75% go to the 3rd technological system, and only 20% and 4,5% go to the 4th and 5th technological systems respectively. In so far as technological capital investments (technical re-equipment and modernization) 83% falls on the 3rd technological system and only 10% – on the 4th (Yerokhin, 2006; Economy, 2003).

Therefore, scientific and technological development in the space sector of Ukraine does not meet the requirements of the time, and the priorities of public scientific and technological policy do not correspond to those prevalent in the world. This technological gap is growing every year, as a trend is that each subsequent technological system undergoes deeper changes, has a more comprehensive structure and properties, has a much shorter time frame.

Assessing the impact of scientific and technological revolutions, Klaus Schwab (Schwab, 2015) argues that new technologies are associated with uncertainty and many difficulties. This

implies the responsibility of all members of the world community, including governments, businesses, scientists, and the public, regarding close cooperation with each other, which is necessary to better, understand the emerging trends. At the same time, he argues that governments are among those who will be most affected by this elusive and ephemeral force – the new scientific and technological revolution.

The coming revolution will affect both the States and public administration. The use of space technology will enable better management. More intensive and innovative use of web technologies can help public administrations modernize their structures and functions to improve overall performance. From strengthening e-government processes to greater transparency, accountability and involvement in the relationship between government and its citizens. Governments will have to change, as their central role in policymaking will diminish due to increasing competition, as well as redistribution and decentralization of power enabled by new technologies. Increasingly, governments will be seen as public service centres, assessed for their ability to deliver expanded services in the most efficient and individualized way. Ultimately, it is governments' ability to adapt that will play a key role in their survival. If they set transparency and efficiency levels for their structures enough for their competitiveness, they will stand the test of time (Schwab, 2015). However, Klaus Schwab doubts that States will not be able to adapt to new changes, and therefore will not be able to apply and implement new space technologies to benefit from them, and new changes will create new security problems.

Therefore, we can conclude that: 1) scientific and technological convergence necessitates the search for ways to adapt to the transformational conditions of modern "knowledge society" in the face of global challenges and the formation of a conceptually new model of scientific and technological development in the space sector; 2) the development of science and technology in space and their convergence determines and provides an opportunity for innovative modernization of approaches to structural organization, functions, mechanisms and methods of public administration for the benefit of people.

Conclusions

The current stage of human development is characterized by global scientific and technological transformations, while the life of society and the state is largely determined by state of the art in science and technology in space, which today affects absolutely all spheres of social reality. Various aspects of human life are subject to space technologization: from the Human Genome Project to e-governance.

The globalization and growing acceleration of technological changes make the issues of convergence of science and technology especially relevant, which requires rethinking and reassessment. This is because the qualitative technological changes taking place in the world and the accelerated speed of such processes require not only individual States but also the world community to form new concepts of scientific and technological development in the space sector, based on the renewed role of States in these processes.

Scientific and technological development in the space sector as a result of a new scientific and technological paradigm is a multifaceted phenomenon, which should be considered as 1) a complex multi-vector phenomenon and the highest socio-cultural value in the development of mankind. Moreover, the multi-vector nature of scientific and technological development is: legal, ethical and moral aspects; positive and negative consequences of technologization of science; responsibilities of all members of the world community (public, scientific, educational,

commercial sectors and civil society, individual representatives of each of them); 2) direct causal link with sustainable and inclusive development, general well-being and social progress in general; 3) an intensive factor influencing: economic growth and competitiveness; national security of the state, and, as a consequence, one of the key areas of public policy.

Therefore, the concept of technological systems is an effective tool for learning the essence and patterns of scientific and technological development in the space sector. The study proposes to use the concept of technological systems as a theoretical basis and reference point for listing priority trends of scientific and technological development in the space sector of Ukraine.

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Public Administration Required in Ukraine for Private Space Rocket Engineering

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The author considers the historical and legal aspects of the development of the rocket and space industry of Ukraine as a heritage of the production of intercontinental missiles within the framework of the military-industrial complex (MIC) of the USSR. The reasons for the advent of the rocket industry in the context of the "cold" war of the 20th century and trends of the rocket and space industry of Ukraine from the structure of public administration remained within the military-industrial complex of the last century are considered. The possibility of overcoming the current impasse in public administration of the industry under the State Space Agency of Ukraine is evaluated, with the involvement of private rocket and space structures, which requires changes in legislation and reveals unresolved governance problems. The author argues that recognition of world trends and their reflection in the Ukrainian legal field is an urgent necessity. The potential way out of the current deadlock situation in public administration of the industry in subordination is evaluated. The analysis enables to determine the necessary actions in a lawful manner to increase the effectiveness of public administration of the Ukrainian rocket and space industry, challenging obstacles to this at the moment, and to make a proposal regarding the trend of formation of public administration of private space rocket engineering on the example of the Ukrainian space project "GreenSpace."

Keywords: public administration, space activities, aerospace industry, law, industrialization of space, private sector, space and rocket industry.

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Introduction

Ukraine is at a critical juncture, searching for ways of effective public administration and reform of the existing space and rocket industry under the State Space Agency of Ukraine (SSAU). However, these ways may be suggested as a result of research on historical, political, legal and technical aspects, specific for previous periods and followed up in practice now.

The current realities of public administration of private space rocket technology in Ukraine face several serious problems:

1. State monopolies remain, not only in the space industry of Ukraine; State-owned enterprise managers receive salaries and bonuses as a result of the monopoly itself and not as a result of deductions from income brought to the State. That is, managers have no interest in performance; moreover, the remuneration received by heads of State enterprises is ten times higher than that received by specialists, leading to unfair distribution of salary funds in State enterprises that violates social justice, while the level of management salaries is maintained by the dismissal of specialists (e.g., according to submitted declarations, the well-being of management of the M.K. Yangel State Design Office "Yuzhnoye" (Yuzhnoye SDO) is at a high level, while from March 2021 to August 2021, 1,040 high-level professionals were dismissed for lack of wages for them, and the process continues).
2. Corruption with embezzlement of budgetary resources in the space industry of Ukraine does not lag behind other departments (Kushnarov, 2018), it leads to the illegal enrichment of management: on 10 September 2021, the Verkhovna Rada of Ukraine adopted Resolution 5477 on the establishment of the Temporary Commission of Inquiry; the objective of which is: "investigation of possible unlawful acts committed by officials of the State Space Agency of Ukraine (National Space Agency of Ukraine), including the implementation of Ukraine's national targeted scientific and technical space programmes; management of State enterprises, economic societies that are (were) under the Space Agency; determination of the reasons for the decline in the financial and economic indicators of the space-related enterprises of Ukraine, the inadequate quality of management and the failure to fulfil the obligations entrusted to the Space Agency; investigation of cases of the bankruptcy of Ukrainian space-related enterprises, abuses in their privatization and the causes and effects of the liquidation of such enterprises; investigation of cases of illegal transfer, sale and other alienation of technologies in the space sector; establishment of evidence of the inappropriate and inefficient use of technologies in the space industry, as well as their inadequate protection (On the establishment, 2021); and finally, investigation of possible wrongdoing in the course of the failed "Lybid" and "Cyclone 4" projects.
3. In Ukraine, a clan-based system of interest in the development of certain high-income sectors of the economy with minimal investment in their provision exists, that is, interest in obtaining a super income at minimal cost for enriching a small part of the citizens of Ukraine, while the rocket and space industry has always been high-cost, but it reflects the interests of the State in developing a high-technology industry, this contributes to the lack of State contracts needed by the Ukrainian rocket and space industry.
4. Ukraine lacks a plan for social and economic development to enhance the well-being and welfare of citizens due to impulsive actions of the Verkhovna Rada, the President and the Cabinet of Ministers of Ukraine for solving immediate problems.
5. Not only the internal clan system, but also the external pressure of foreign States acting in their own interests, are seriously hampering the development of the Ukrainian rocket and space industry, for example, the US State Department periodically sends to the Ministry of Foreign Affairs of Ukraine "letters of regret" about the travel of Ukrainian specialists to China, one of the world's leading rocket and space

countries with huge resources for joint work with Ukraine (Soroka, 2019); since 1991 the Russian Federation has made a lot of efforts to destroy the basis of the defence industry in Ukraine, for example: aluminium smelter (PJSC "ZAlK"), and "Ukrgrafit" in Zaporizhzhia, "Dniproshyna" in Dnieper do not produce for the space industry, JSC "Nikopol Welded Pipe Factory" was closed in 2017 (these and other enterprises were built to ensure production of ICBM in Ukraine), the Donbass factories have been taken away from Ukraine and destroyed: the only way to escape foreign influence is the independent course of the State of Ukraine in the process of the development of industry and other branches of the economy.

The author uses the results of research in the former Soviet Union and in the world, taking into account historical aspects of various periods of the development of public administration of space activities, by Alexey Zherebtsov, Natalia Malysheva, Larysa Soroka, whose work is further referred to.

Prerequisites for development of space and rocket technology under legal confrontation between States

World trends in the development of the rocket and space/aerospace industries have identified three evolutionary stages (Alamalhodaei, 2021):

1. Old Space or Heritage Space involves everything created by the governmental structures of different countries, with almost unlimited financing from the budget, because the introduction of developed technologies into the economy was considered optional and even impossible due to the increased level of secrecy in the interests of defence. Hence, Old Space has assumed non-renewable defence costs.
2. New Space provides for the use of private business by attracting both public investment (Space-X, Rocket Lab in the United States, and some others) and venture investment companies from own funds (Firefly Aerospace in the United States), as well as the participation of non-State companies in projects of State corporations (participation of JSC Dneprotyazhmash in project Cyclone-4, Yuzhnoye SDO), which implies a reduction of total costs and payback of implemented projects.
3. Industrial Space aims at integrating space technologies into the economies of countries; this trend is supported by the legislation of two countries, the United States and the Grand Duchy of Luxembourg, which have the right to extract minerals from outer space and to use them, for example, in 2021, in the United States, Varda Space Industries launched the first Orbital manufacturing start-up with $42 million from a group of investors (Khosla Ventures, Caffeinated Capital, Lux Capital, General Catalyst, Founders Fund).

The rocket and space/aerospace industry should generate profits and extra profits from the use of space technologies.

At all these stages of development, public administration of the rocket and aerospace engineering industry is changing significantly. Ukraine, unfortunately, remains in a flawed phase of Heritage Space, in which the concepts and future programs of the SSAU are doomed to failure. At present, Ukraine has ceased to be perceived as a spacefaring nation in the world, and Ukraine is of interest to some countries only as a producer of USSR-era ICBMs.

Historically, Ukraine is a fragment of the Imperial USSR with a highly developed MIC with a share of 25% and a system of central administration in the form of the Soviet model MIC (Pikhoia, 2016; Bystrova, 2010; The Soviet, 2010). With regard to missile technologies (the basis of the future space industry of Ukraine), there was a so-called missile "South Bush*"* (Domestic, 2013), which formed the technical equipment of the Strategic Missile Forces of the USSR (Krivolapov, 2019; Smirnov, 2016). Immediately after independence, Ukraine established Rocket and Space Forces Command in Kyiv (On Military, 1991). Then these forces were disbanded (on 5 April 1992, 43 missile armies with 5,000 nuclear weapons were incorporated into the Armed Forces of Ukraine by Presidential Decree 209 and then disbanded by 01 June 1996, all nuclear warheads were removed to the Russian Federation), and intercontinental missiles removed from alert and destroyed (by 30 October 2001) under international agreements (Antonov, 2012; Memorandum, 1994; On Ukraine's, 1994) or transferred under various conditions to the Russian Federation by 2004, as well as all completed and unfinished Ukrainian projects (From Confrontation, 2004).

The established National Space Agency of Ukraine began to form scientific and technical programmes, for which the Law of Ukraine "On Space Activities" (On Space, 1996) was adopted. For some period, missile factories and organizations in Ukraine remained orphaned, and then they became subordinate to the transformed State Space Agency of Ukraine (1999). In fact, independent Ukraine received a huge missile heritage from the former Soviet Union and in 1991 was significantly higher than, for example, the People's Republic of China (Lee, 2013). By 2021, Ukraine's rocket and space industry had been completely destroyed (Levenko & Drozdenko, 2021), and the People's Republic of China had taken the leading positions in the world with its moon rovers and Mars rovers, an orbital station and emergency-free launch vehicles launching hundreds of high-quality satellites from China's cosmodrome (Zhelezniakov, 2021; Kashin, 2016; Blue, 2021). Nowadays, Ukraine cooperates with China (Soroka, 2021) and buys in China high-resolution Earth remote sensing data directly from Chinese satellites flying over Ukraine.

Therefore, in the post-Soviet period, Ukraine lost the defensive vector inherent in the missile component of the MIC. So far, it has not adapted to the challenges of the peaceful exploration of outer space with the commercialization of space technologies. This problem can be solved by establishing public administration of private space rocket production as one of the promising types of space activity in Ukraine.

Space rocket engineering in Ukraine and specificities of its public administration

Let us briefly discuss the specificities of public administration of space rocket engineering at all stages of development mentioned above.

The first United States ballistic missile was successfully tested in 1958 (ICBM Atlas) and in the USSR in 1957 (R-7).

The system of public procurement and administration was innately different in these countries: it was a political issue related to the legal framework of each country. As early as 1957, the United States produced the world's first submarine-launched ballistic missile Polaris A1. Since 1960, these rockets had been launched at Cape Canaveral, their rungs fell into the Atlantic, and their second rungs ended up in the middle of the ocean, where they were successfully fished by Soviet fishing trawlers. The author was fortunate in his occupation to

disassemble and study the Polaris A1 steering wheel drive. While the Soviet Union produced more powerful and perfect copies of Aggregate-4 (Germany) until almost the 1970s, in that case, the author saw a technique that we had not had yet. The drive was powered by a hydraulic amplifier, where the gap between the cylindrical plunger and the shuttle sleeve was two microns. Up to the end of the USSR, it was possible to make the same with a gap of at least five microns. There were other interesting design solutions too.

Initially, in the USA, the industrial base was more developed, all branches of the economy worked effectively (Post-war, 2017). Already in the 1960s, liquid rocket engines were manufactured on the conveyor.

The most interesting thing the author saw was that on every hull part of the American steering wheel drive, there was a round blue ink seal: Kodak, 1957. The USA engaged private corporations in production, including the camera company Kodak. It specialized in missile control systems, designed and manufactured satellites, including those with nuclear power plants (Kodak Research Laboratories / Engineering Research Division).

In the USSR, the administration was simpler, without taking into account historical and world experience (Zherebtsov, 2016): all financial resources of the country were mobilized, at 2 a.m. the Minister of the special Ministry carried out operation meetings at the serial missile factory p/ya 186 (future Yuzhmash), the State security services exercised total control, it has not been common to write about this until now. In the absence of developed industry and technology manual labour flourished; first machines with digital programme control developed on Yuzhmach only in the 1970s. Besides, the plant had to be transformed from the largest in the USSR post-war automobile plant. The city of Dnipropetrovsk was closed to foreigners, while usually settlements and small towns in the Russian hinterland, in Siberia, on the Urals were closed.

Inside the secret factory, p/ya 186, an even more secret design bureau p/ya 2289 was created.

At first, the standards for effective cooperation in missile production were absent. Therefore, so-called "Guiding Documents," secret folios, were used, which regulated all requirements for constructions, their testing and their manufacture. Later there were secret military GOSTs, followed by the Unified System of Design Documentation, the Unified System of Technical Documentation, the Unified System of Technological Documentation. This was necessary because materials, parts, individual products were produced by hundreds of thousands of general technical enterprises (at which, by the way, military reception was introduced with increased requirements for the quality of production).

For example, the Moscow region plant manufactured steel gramophone needles. Without them, the cases of solid rocket engines could not be made. Therefore, needles continued to be manufactured even after the gramophones had ceased to be used.

A centralized system of public administration for intercontinental ballistic missiles in the USSR was formed. The administration was carried out directly from Moscow under the control of special commissions of the CPSU CC and the Cabinet of Ministers of the USSR.

One such missile segment of the administration was the industry of the Ukrainian SSR.

After the collapse of the USSR and the declaration of independence, the public administration of missile enterprises of Ukraine did not change. Still, at the same time, the administration centre (Malysheva, 2018) disappeared, and the government of Ukraine did not load missile factories with State order.

Reform was needed, and the enterprises themselves understood this first and foremost. As early as a quarter of a century ago, Yuzhmash workshops were given the right to create scientific production enterprises according to their work profile, to employ designers from the Yuzhnoye SDO. Unfortunately, they did not gain legal independence remaining within the State enterprise, and their products proved to be uncompetitive at a high price and a low level of technical excellence: Yuzhmash could only effectively manufacture intercontinental missiles (during the years of independence in Ukraine, only six technically imperfect experimental satellites were additionally designed by the Yuzhnoye SDO and manufactured by Yuzhmash). However, this tradition remained, and until now is used in the Kyiv State Joint-Stock Holding Company Artem (production of missile weapons), 1996 (Artem, 2021).

Later the structures of some State enterprises under the State Space Agency of Ukraine were reformed.

JSC Hartron was divided into 15 enterprises (JSC, 2021). The State Joint Stock Holding Company Kyiv Radio Plant united 16 enterprises (Kyiv, 2021), including private company Elmiz, company Kurs. Arsenal State Enterprise of Special Instrumentation was divided into three enterprises (Arsenal, 2021), in particular private company Skynet.

It should be noted that the number of independent and non-State space-orientated enterprises has constantly been increasing in Ukraine. Laboratory of Advanced Rocket Engines LTD (production of aircraft and spacecraft, satellite equipment, registered in 2016, works with foreign partners through the Ukrainian Scientific and Technical Centre) works only in Dnipro; R&D-centre (Noosphere Association) works with Firefly Aerospace (USA) and Skyrora (UK); Space Logistics Ukraine; SkyEnergy LLC works with ISISPACE (Netherlands) and others.

2021 for Ukraine became the Rubicon, having passed which space industry in Ukraine should become alternative. It will require the administration of partially private but fully State-controlled industry (On Space, 1996). Since the adoption in Ukraine of Law 1071, which enables non-State companies to engage in space activities, including firing tests, the real situation has only been regularized (Posheliuzhnaia, 2021); this has been accepted as a signal that the State supports space activities that can contribute to the State budget.

It should be considered that this is possible only under the "industrialization of outer space." The former canons should be rethought in order to realize that industrialization requires entirely different technical means and other public administration.

The first stage (Old Space) was supported with intercontinental missiles with parameters: maximum range, maximum accuracy, a maximum weight of the combat unit, maximum convenience for military specialists.

The second phase (New Space) requires a reduction in the cost of taking cargo into space and comparatively cheap spacecraft.

The third phase requires:

a) Low-cost reusable means of transporting cargo into orbit and returning products from space to Earth;
b) Low-cost and reliable reusable environmentally friendly engines;
c) A simplified start-up system with no construction and maintenance costs, e.g., taking into account the closed location of the territory of Ukraine, with limited alienation fields at start;
d) Switch to low-cost, reliable, high-tech, low-mass spacecraft (lower cost of satellite launch);
e) International cooperation.

Why are the State enterprises of Ukraine not ready for the realities of the "third stage"?

First. Monopoly status of leading space industry enterprises (Competition, 2020). Leading Yuzhnoye SDO does not want to give up the designs of combat missiles and design launch vehicles with a vertical flight of the first stage (for a significant reduction of fields of alienation): even the heavy-lift launch vehicle of China Long March-5 for the first stage (liquid launch accelerators CZ-5-300) requires a territory of length 90 km and width 30 km (China, 2020), while in the projects of Ukrainian Yuzhnoye SDO it is hundreds of kilometers (Karpus, 2019).

Second. Reluctance to stay ahead of the world's technological advances due to the lack of motivation. It is enough to compare the new Earth remote sensing satellite Sich-2-1 with the European one; Ukrainian apparatus is worse in parameters than CubeSat-6, which has a ground resolution of 4.75 m, useful life of 5 years, the weight of 6 kg, additional control of air traffic is carried out (controls for airport controllers without ground radar, implemented in North America, Europe, partly in China).

Third. The reluctance of the State to establish Ukrainian GOST systems. Ukraine has virtually no State standards in the space industry (with the exception of a few for Earth remote sensing). Under an international agreement, Ukraine uses GOSTs of the USSR (in Russian, as the language of international communication), which results in prohibiting the use of certain GOSTs by the State Space Agency of Ukraine without offering anything in return. At present, any space projects should be on the basis of standards: in Ukraine, they should be carried out in Russian, since there are no standards in Ukrainian, which is totally contrary to the public policy of Ukraine and reduces opportunities for State enterprises.

Fourth. The imperfection of public administration of the space industry within the remnants of the USSR-era MIC, inherent only to the first stage of the Old Space. It is necessary to abandon State programs with the "sole performer" in Ukraine, because it is nothing other than monopoly and corruption, which contradicts the legislation of Ukraine.

Fifth. The conservatism of State enterprises, which are already accustomed to a closed type of activity, separated from State plans for social and economic development: the development of the industry is carried out for the industry. In the PRC, for example, the opposite is true: the plans and activities of enterprises and organizations of rocket and space activities are included in China's five-year socio-economic development plans and are mandatory even at the regional level (Levenko & Drozdenko, 2021). Accordingly, the implementation of plans in China is subject to serious State and party control. Why should Ukraine not adopt some of the Chinese experience? There are many parties, but the leading party, the CPC, is present in all structures and is also responsible to the State for failure to implement plans. In Ukraine, a similar situation has developed: the party "People's Servant" is present in all branches of government but is not yet ready to control everything in the interests of the development of the State and to be responsible for failure to implement plans. The party forms a majority in the Verkhovna Rada and adopts, for example, the space program of Ukraine and should not remain an outsider.

Sixth. The reluctance of state-owned enterprises to receive income and profits, which is possible with irrevocable financing of works (with corruption component of enrichment on legal grounds of management of state-owned enterprises). Unwillingness to sell own products on the world market is evidenced by the innumerable appeals to the SSAU and management of foreign enterprises, and as a result, there are only a few commercial projects that cannot feed the industry.

Seventh. The State is not interested in Technoparks, which aim to transfer technologies to Ukraine, import-substitution, and develop production facilities. Moreover, technical universities are being dismantled for the training of specialists, specialized colleges, and industrial and technical colleges.

It is possible to continue. However, what is already being done on a private initiative in the space sector should be noted.

GreenSpace as a promising Ukrainian private rocket engineering project

One of the new private space companies of Ukraine, Science & Space LLC, guided by the principles of public administration and aware of the importance of the industrialization of outer space for the economy of Ukraine, has developed a Technical Proposal for a new launch vehicle GreenSpace (RCK) suitable for use in Ukraine.

First of all, technology should be considered. The launch vehicle implies the latest achievements of the Ukrainian rocket engineering of the USSR-era, developed in the system of the military-industrial complex, which are now not used by state enterprises under the State Space Agency of Ukraine.

It is a fire dynamic launch from a launch pod container. This launch significantly simplifies the launch site requirements and preserves the launch vehicle with useful cargo until launch in a normal climatic environment. In contrast to the military variant, the launch pod container does not use a powder pressure accumulator, instead water is filled, and the steam overheated by hot jet of a liquid propellant engine performs the work of a conventional steam engine: discharging the missile from the container at speed required. This enables to place the entire flight control system and the operating mechanisms of this system on the second stage of a two-stage rocket. The engines in the rocket are fixed motionless, the head part with a useful load is deflected, changing the position of the centre of mass relative to the drive vector of the engine, and in dense layers of the atmosphere, this enables to apply of aerodynamics.

The swing of the head part for flight control is well known and described (Igdalov et al., 2004). The launching of rockets from a launch pod container (Karpenko et al., 1999) is also well known. The combustion of liquid non-cryogenic fuel in the rocket engine also generates steam. Technically it is a modern environmentally safe rocket "steam engine," a working horse of space industry. The design and use of the launch vehicle are patented in Ukraine (Patent, 2021).

The complex is designed for the launch of modern CubeSat satellites to a sun-synchronous orbit with altitudes from 500 to 900 km to monitor the territory of Ukraine and other countries: one launch is capable of forming an entire constellation of dozens of satellites in orbit.

It is possible to modify the vehicle: the design makes it possible to increase the number of chambers of similar liquid rocket engines. As a result, it is possible to launch a cargo of up to 500 kg or an orbiter with a space plant into space for the production in vacuum and weightlessness of unique products up to 100 kg. This flexibility is provided by a system for supplying fuel to the engine at a high nitrogen pressure without the use of a turbo-pump unit. High-pressure tank residues are used for the controlled return of the first and second stages by parachuting them and by plucking stages out of the sky using a helicopter.

The launch vehicle and the launch pod container are reusable, and the rocket can be launched up to 10 times (the results of the tests may lead to an increase in the number of launches), and the next launch is possible within 24 hours.

Thus, the technology is well suited for the stage of "industrialization of outer space." Moreover, the possibility of launching a launch vehicle from the territory of the former bombing range on the peninsula of Yegorlytskyi Kut has been worked out. The track runs over the Black Sea, and the first stage lands at a distance of no more than 200 km from the launch point above the sea. The second stage crosses the Turkish air border at an altitude of over 100 km. In the event of an emergency and the failure to restart the second-stage engine to reach the required altitude, the second stage will fly on a ballistic trajectory and parachute into the Sahara Desert at the border crossing point between Libya, Sudan and Chad.

This launch completely contradicts the official view that it is impossible to launch a launch vehicle in Ukraine. Perhaps, we need to understand which missiles Ukraine needs.

Technically, private initiative is quite applicable in Ukraine.

With regard to the public administration of private space rocket engineering, Ukraine is theoretically ready: the legislative basis is sufficient, the management structure of a private company has no relation to the vertical military-industrial complex, Ukraine can buy most units, assemblies, fuel components in Europe (Ukrainian and European legislation allows). Cooperation with other private enterprises of Ukraine, joint-stock companies, investment funds is possible. However, even attempts to include the private enterprise, or more precisely its subject matter, in the space programme is not supported by the management of the SSAU. This is due to the inability of public administration by the SSAU in accordance with the legislation of Ukraine: Regulations on the SSAU (Regulations, 61), by-laws of the CMU and other governing documents do not specify the rights of private enterprises.

Moreover, private space companies are ready to execute orders of State structures of Ukraine. Therefore, effective public administration will produce results as soon as possible with high economic efficiency. Foreign experience demonstrates this under completely different systems of government (USA, PRC, Republic of Korea, Islamic Republic of Iran, and Germany). All of these countries are present in outer space; all of them do not use the public sector of the economy.

There is a readiness to pass the Ukrainian Rubicon and join the world community of the space industry (Kushnarov, 2018). Of course, by working for the benefit of the country, private space companies hope not only for government control, but also for support. The efficiency of the space industry requires in the first years of a specific project that: the company is exempt from taxes (before the project is put into operation), components can be imported without duty; this does not require financing from the State. Genuine support implies concessional loans granted to the private space industry under State guarantees if the project is approved and accepted into the State space program.

Such enabling environment for private space rocket engineering should be created in Ukraine, and a new system of public administration of the space industry should be established.

Conclusions

The effective operation of the Ukrainian space industry and proper public administration of the private space rocket engineering require:

a) Unconditional introduction of legislation into the practical activities of State and non-State administrators;
b) Planning in the interests of the State in accordance with the provisions of Ukrainian legislation;

c) Corporatization of space State enterprises with changes in the system of legal administration;
d) Introduction of a system of authority in Ukraine at all levels with imminent liability for violations of the law at all levels of administration and for the absence of programmes for the social and economic development of the country and of individual branches of the economy; and liability for failure to comply with their duties in general.

This does not require additional funding. It is enough for Ukraine to become a State really governed by the rule of law in the context of the laws already adopted, with their number limited and with the transition to quality.

This is possible provided the adoption of the Fundamental Laws of Ukraine by the Verkhovna Rada to eliminate the ambiguity in the country that generates negligence and to eliminate the legalization of illegally appropriated finances and industrial and infrastructural facilities; on the basis of introducing people's rule in the form of referendums as a system for monitoring the actions of the authorities; introduction of planning for the social and economic development of Ukraine with a view to improving the standard of living of Ukrainian citizens.

In this context, public administration of the space rocket industry will function as national law and order. This industry cannot exist in a closed structure, separated from the State.

The study of the causal relationships that determine the logic of the events and the final outcome of the actions led to the conclusion that what needs to be done is known, but at present, this is not possible.

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New Frontiers of Sustainable Human's Activities: Challenges for Legal Order of Space Mining Economy

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The exponential development of space activity due to plans to expand space activity on the Moon and other celestial bodies raises many legal tasks to solve in the future. There are a lot of international and national initiatives to build the legal framework of a future sustainable space mining economy. This article is focused on reviewing such initiatives for the aim to reveal the main issues concerning fostering the sustainable development of the space activities on the Moon and other celestial bodies. As a result, the common procedure of the advancing governance, safety zones establishing criterions, the institutionalization of the general recognition of the property rights, benefit-sharing model, interoperability of the internal authorization procedures and technical standards enabling safe and sustainable space mining activities, authoritative dispute resolution procedures have been distinguished. They should become as main conceptual mechanisms for further international and national law-making process.

Keywords: space mining, sustainable space activity, safety zones, global commons, space resources.

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Introduction

The main feature of the economy is that consumption is expending resources taken into production. Decades of combating this paradigm emanated from the "Our Common Future" report that was the focal point for developing the avalanche of international treaties, arrangements, national environmental policies, programs, and laws, showing persistence of the concept of consumption and paucity of the measures against them. The evidence is the statement of Sheila Aggarwal-Khan, Director of Economy Division at UNEP: "planetary crises of pollution, climate change, and biodiversity loss are caused by unsustainable consumption and production" (Aggarwal-Khan, 2021).

Exhaustion of the resources pushes humanity to find solutions beyond the Earth and even near-Earth space that also has suffered and continues to be suffering from unprecedented littering (ESAs, 2021). This scenario was predictable, so the authors of the Moon agreement prescribed that State Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the explorations of natural resources of the Moon as such exploration is about to become feasible. Such procedures shall meet the purposes with ecological connotation, such as orderly and safe development of natural resources of the Moon, rational management of those resources, the expansion of opportunities in the use of resources. The obstacle became the recognition as a common heritage of humankind the Moon and its natural resources (Agreement, 1979). It is different than the recognition of the exploration and use of outer space, including the Moon and other celestial bodies as a province of all mankind according to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Treaty, 1967). As a result, when the time has come, the law-making process went the other way than prescribes the provisions of the Moon Agreement.

Initially, USA and Luxembourg adopted national legislation for fostering private space mining activities. Then the Legal Subcommittee of the Committee of Peaceful Uses of Outer Space (COPUOS), starting from its 56th session, in 2017, considered the agenda item on the general exchange of views on potential legal models for activities in exploration, exploitation, and utilization of space resources (Annotated, 2020). The global scientific community reacted by developing different models of space mining global legal order, like Hague Building Blocks for the Development of an International Framework on Space Resource Activities (Building, 2019), Moon Village Association Principles (Moon, 2020), EAGLE Lunar Governance Charter (Effective, 2021a), some especially focus on environmental issues as Vancouver Recommendations on Space Mining (Vancouver, 2020) and Declaration of the Rights of the Moon (Declaration, 2021).

A new cycle of potential models, rules, and norms development, for activities in the exploration, exploitation, and utilization of space resources, including with respect to related activities and benefit-sharing, starts from US governmental initiatives Artemis Program (Artemis, 2020) and China-Russian's International Scientific Lunar Station (China, 2021) with intergovernmental arrangements and legal framework. The level of necessity of elaboration common legal framework concerning such issue led to submitting a proposal for a Working Group on Space Resources to be established by the Legal Subcommittee at its 60th session in 2021 under a five-year work plan (The Establishment, 2021).

This article aims to highlight the most important legal mechanisms for the Working Group on Space Resources. To the aim, authors plan to focus on reviewing the abovementioned policy,

legal and scientific suggestions and then, in conclusion, to reveal the main issues concerning fostering the sustainable development of the space activities on the Moon and other celestial bodies.

Sources of Establishment Legal Order of Space Mining Economy

National law and policy

As two hundred years ago, the news about valuable resources (water, regolith, platinum, etc.) induced private actors to find the possibility to occupy them. There are many startups that arose with seeking funding for projects of exploitation of space resources. Recognizing international responsibility for such activities and possible budget revenues in consequence of them, some States use their public power for fostering private initiatives. For instance, Japan has created the Space Exploration Prize, Innovation Network Corporation of Japan (a public-private investment fund), and the Development Bank of Japan (which is government-owned) (Brunswick, 2021). The Grand Duchy provides funding via LuxIMPULSE, the national program, or the different State aids for the promotion of Research, Development, and Innovation is participating in the establishment of a space fund and established the cooperation with European Investment Bank (National, 2019). The same steps were made by such Middle East States as UAE (Emirates, 2021) and Saudi Arabia (Public, 2021). Four States adopted their national legislation in this sphere: the US, Luxembourg, UAE, and Japan. The main feature of such legal frameworks are a statement of legality (for proving the accordance with art. 2 of OST) of extraction of space resources, grant the property rights for miners as a ground for their motivation to spend the money for such ventures, authorization or permission system that surely emanated from the obligation prescribed by art. 6 of OST. However, approaches to regulation were different and in common sense to complement global understanding of the legal order of the space mining economy.

By authorizing US citizens to extract materials from asteroids through the Commercial Space Launch Competitiveness Act 2015, the United States has started down a path in which property rights in space flow from the jurisdiction of individual severing nations (Heise, 2018). This act first limited the space resources only by abiotic in situ extracted resources and enshrined by a wide range of titles, including to possess, own, transport, use, and sell the asteroid resources or space resources obtained in accordance with applicable law, including the international obligations of the United States. Herewith authorization and continuing supervision by the Federal Government are integrated into the general system of authorization over space activities. Nevertheless, as practice showed, this was not enough for fostering private space activities. The Federal Government promotes an environment that encourages investment in the space economy, which can reduce risk to the private sector for new technologies such as space mining and manufacturing. For instance, NASA uses commercial service contracts within the Artemis Program, including those governing transportation, communications, and power systems to facilitate the return of manned missions to the lunar surface and encourage their permanent operation there (Exploring, 2021). Reorientation from the encouraging private initiatives to the strong Governmental support of space mining activities is reflected in Executive Order (EO) 13914 issued by US President Donald Trump on 6 April 2020. This act rejected the concept of global commons and Moon Agreement as an international instrument and officially enshrined to negotiate a set of international arrangements regarding safe and sustainable operations for the public and private recovery and use of space resources under the auspices of the Artemis

Program (Encouraging, 2020). The same aim facilitating the active space-mining activities pursues by the Space Policy Directive 6 National Strategy for Space Nuclear Power, Propulsion (Memorandum, 2020) and National Strategy for Space Nuclear Power and Propulsion the Executive Order (Promoting, 2021). These acts draw the model of functioning on the base of the clear roadmap of the space nuclear power and propulsion system that is based on the safety, security, sustainability principles. Noticeable the provision about planning and conducting operation and disposition of such systems in a manner that protects human and environmental safety and national security assets that could be evidence of the formation of some environment protection norms for space mining activities.

The Luxembourg Act about the exploration and utilization of space resources 2017 create the legal background from scratch. It grants the ownership rights for exact types of companies of Luxembourg law or a European Company having its registered office in Luxembourg. It also requires the robust scheme of financial, technical, and statutory procedures and arrangements through which the exploration and utilization mission, including the commercialization of space resources, are planned and implemented, including the risk assessment and all such information as may be useful for the assessment thereof as well as by a mission program (Loi, 2017). However, there is no exact requirement concerning the protection of the environment of the celestial bodies or rational, reusable exploitation of space resources.

UAE's Federal Law on the regulation of space sector 2019 stated that "space resources as non-living resources present in outer space, including minerals and water and Space Nuclear Energy Sources as services used in Space Activities to generate energy and using nuclear materials, radioisotopes or a nuclear reactor." This Act also prescribes the obtaining permits for the exploration, exploitation, and use of Space Resources, including their acquisition, purchase, sale, trade, transportation, storage, and any Space Activities aimed at providing logistical services (Law, 2019), but is not provide any details for requirements need to be fulfilled for this. On 15 June 2021, the Law Concerning the Promotion of Business Activities Related to the Exploration and Development of Space Resources grants Japanese companies permission to prospect for, extract and use various space resources (Foust, 2021).

Thus, national legislation as an upstream source for the future global legal order of space mining economy is valuable by granting the property rights or titles based on the authorization conditions according to respect the OST rule for international responsibility of the national space activities, and rule emanated from the sovereign rights of the States. Since sovereign rights over space, resources cannot be posed according to art. 2 OST, the international legal framework could be elaborated because of the mutual recognition of the legality of activities of private space entities through soft international law instruments such as arrangements, memorandums of understanding (the core of Artemis Accord or China-Russian`s International Scientific Lunar Station). In this context, enhancing the sustainable space mining economy can be provided by harmonizing technical and legal requirements to space resource extraction and using motivated by comprehension of limitations and exhaustiveness thereof.

Soft law and intergovernmental arrangements

For the first time, the concept of sustainable development was reflected in the Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space adopted by the COPUOS in June 2019. Special attention should be paid to Guidance D.1 prescribes that States and international intergovernmental organizations should promote the development of technologies that minimize the environmental impact of

manufacturing and launching space assets and that maximize the use of renewable resources and the reusability or repurposing of space assets to enhance the long-term sustainability of those activities (Guidelines, 2018). This norm could be considered as a starting point for taking into consideration ecological issues within the space mining economy.

Further progressive development of international law and policy in this sphere is connected with the formation of two coalitions of like-minded partners within the Artemis Program (Artemis, 2020) or International Lunar Research Station (International, 2021). The legal framework of the first ones is formed and still forming through the numerous bilateral arrangements regarding distribution tasks for implementation of the joint project under the auspices of the common principles, known as Artemis Accords (yet 12 State Parties: Australia, Brazil, Canada, Italy, Japan, Korea, Luxembourg, New Zealand, Ukraine, United Arab Emirates, United Kingdom, United States of America).

The second program only starts to elaborate a legal framework with potential partners that is divided into 5 categories of cooperation (space mining, space system, subsystem, equipment, ground, and application). Joint Working Group consists only of China and Russian Space Agencies, but it plans to develop within Legal Group to analyze applicable international law, make the inter-governmental agreement planning, inter-agency agreement planning, and agreement drafting and singing. Both programs provide interoperability of standards in the field of launch vehicles and spacecraft technology development scientific and technical data sharing within the Parties of each Program, taking into consideration export control requirements.

This bipolar legal framework for the space mining economy makes the efforts of the COPUOS. Legal Subcommittee extremely important to promote the sustainable exploration and use of space resources for future generations through dialogue, transparency, and capacity building based on shared values, the key to which should be the protection of the natural environment of celestial bodies. Significantly, both Programs did not reject multilateral efforts to further develop international practices and rules applicable to the extraction and utilization of space resources within the COPUOS.

In this context, it should be noted that Artemis Accords orient their Parties for establishing the sustainable human exploration of the solar system exclusively for peaceful purposes and in accordance with relevant international law through such modes of behavior. First, utilization of space resources should serve the purpose to provide critical support for safe and sustainable operations. Second, informing the public and the international scientific community of space resources extraction activities. Thirdly concentration the precautionary principle and requirement for rational usage of natural resources within article 11 concerning deconfliction of space activities. Reflection of the precautionary principle is the rule about the obligation to refrain from any intentional actions that may create harmful interference with the use of outer space in activities under these Accords. On the other hand, orbital debris mitigation measures as much as principles related to safety zones are the bright manifestation of the rational approach to the use of space resources. As a criterion of the rationality of the extraction and utilization of space resources operations were highlighted scientific and engineering principles and time.

Such legal requirements are good ground for diversifying the measures of the international legal framework for sustainable space mining economy according to adaptive governance and probably the enabling concept of the global commons in a military or geopolitical context. The last one implies a focus on the use of an open-access domain and the consumption of that resource frequently used concerning seabed and even some overcrowded space orbits (Goehring, 2021). Such suggestions were reflected in the civil society and academia suggestions.

The first attempt to fill the gaps in international law concerning space mining activities on the basis of five space international treaties was the activity of the Hague International Space Resources Governance Working Group adopted the Building blocks for the development of an international framework on space resource activities (Building, 2019). The prejudice of their activity was the hypothesis that space resources activities should be incrementally addressed at the appropriate time based on contemporary technology and practices. Taking this into consideration, some progressive mechanisms were suggested. First, clear sustainable approach visible in the principles, i.e., prevention of disputes arising out of space resource activities; promotion and secure the orderly and safe utilization of space resources; promotion of the sustainable, rational, efficient, and economic use of space resources; promote the use of sustainable technology. Second, authors suggest harmonizing the public and private interest, namely the needs of developing countries and science with the contributions of the pioneer operators, suggesting to attribution of priority rights to the last one but under the condition of the registration of the priority rights, prior authorization, and advance notification of space resource activities (Building, 2019). Noticeable that sharing of benefits arising out of the utilization of space resources considering not from the shearing of property rights, but from the facilitating the free access to this activity for as many parties as possible (so-called enabling concept of the global commons).

The concept of safety zones and protective heritage sites emanated from such document, which prescribes more restrictive measures such as the possibility in accordance with the area-based safety measure to restrict access for a limited period, provided that timely public notice has been given setting out the reasons for such restriction. A progressive measure should also be noted establishing the list of designated and internationally endorsed outer space natural sites and technical requirements. They should ensure conformity assessment and standardization, avoiding harmful impacts consisting of detailed list, for instance, harmful contamination of celestial bodies, taking into account internationally agreed on planetary protection policies; harmful contamination of outer space; harmful effects of the creation of space debris; harmful interference with other on-going space activities, including other space resources activities, etc. (Building, 2019).

A similar, but less comprehensive document suggests the non-governmental organization Moon Village Association, so-called MVA Principles. The distinctive feature is promoting the development of private activities on the Moon and in cislunar space, including purely commercial activities, such as space tourism and resources extraction, as well as non-commercial private activities, such as science and exploration. Recently on the base of this organization was established the Global Expert Group on Sustainable Lunar Activities (or GEGSLA) consists of governmental and academic representatives all over the world. Their goal is preparation the Framework and Key Elements for Peaceful and Sustainable Lunar Activities and Guidelines for lunar activities implementation and operations addressing lunar debris mitigation, benefits sharing, sharing of information, registration of activities, regulating access to natural resources for the consideration of the 65th session of the Committee on the Peaceful Uses of Outer Space in 2022 (Report, 2021).

Recently on the base of the Space Generation Advisory Council was also established project named the Action Team on Effective and Adaptive Governance for a Lunar Ecosystem (EAGLE). Their aim is to elaborate the Lunar Governance Charter for restating the fundamental rules of international space law that should address ten aspects: 1) inclusiveness; 2) interoperability; 3) human life protection; 4) heritage preservation; 5) science/business

balance; 6) use of lunar resources; 7) safety zones; 8) registration and liability; 9) minimum coordination; 10) conflict resolution. Let`s consider some most specific of them. Inclusiveness suggests understanding as involving all States in lunar operations to engage in capacity building and benefit-sharing activities, so the Charter needs to include an Annex laying down a protocol for internationally agreed benefit sharing and capacity building mechanisms for lunar activities. For implementation, the requirement of interoperability, the Charter should invite States to identify a global platform for the multi-stakeholder development (and subsequent regular updates) of multiple open international standards for lunar activities.

Following the attempt of the Hague building blocks, EAGLE suggests developing a list of internationally recognized scientific sites on the Moon, including appropriate preservation measures and recognizing the role of pioneering commercial operators (science/business balance). Like the conditions for establishing safety zones according to the Artemis Accords, this working group also suggests that Moon's territorial-based uses must be limited in time and size to ensure compliance with Articles I and II OST. The peculiarity of their proposal is a list of internationally recognized scarce resources and appropriate preservation measures as soon as scientific and technological occurrences that in our opinion is a good idea from an ecological point of view, but exceedingly difficult to achieve from the political side of such issue. To ensure uniformity in the national regulation of lunar activities, the Charter should invite all States to develop dedicated licensing systems for private lunar missions based on the principles of this Charter. To prevent contrasts among these missions, the Charter should invite all States to mutually recognize foreign licenses on the basis of reciprocity (Effective, 2021b).

Less ambitious, but not least for their significance, were so-called open letters of academicians that are deeply concerned about humanity's consumer approach to the natural environment of outer space. Vancouver Recommendations on Space Mining prepared by the Outer Space Institute, recommend multilateral negotiations on an international regime for Space mining and highlight that adoption of national legislation cannot ensure space mining activity safely and sustainably. This document suggests: to consider models or analogies from other areas such as deep seabed mining; to prevent potentially damaging activities even in the presence of scientific uncertainty; to encourage the application of the Committee on Space Research (COSPAR.) Planetary Protection Policy to all Space mining missions and further develop standards on planetary protection. The last one now is especially actual according to Beresheed mission led to tardigrades contamination. The recent NASA Planetary Protection Independent Review Board has led to the announcement of a reframing of the COSPAR guidelines for the Artemis program (Cheney et al., 2020). The authors of the Vancouver Recommendations on Space Mining also appeal to provide publicly available astrogeological surveys, astrodynamical analysis in advance of all Space mining, develop international standards for the prevention of fully consuming or destroying some celestial bodies, etc. (Vancouver, 2020).

In 2020 the Center for Democratic and Environmental Rights, space archeologist Dr. Alice Gorman and research/author Ceridwen Dovey to collaborate together on the drafting of the Declaration of the Rights of the Moon. The text recognizes the legal personhood of the Moon, from which emanated such rights: to exist, persist and continue its vital cycles unaltered, unharmed and unpolluted by human beings; maintain ecological integrity; be defined as a self-sustaining, intelligent, cohesive, intact lunar ecosystem, beyond current human comprehension; independently maintain its own life-sustaining relationship with the Earth's environments and living creatures; remain a forever peaceful celestial entity, unmarred by human conflict or warfare

(Declaration, 2021). The authors are not expecting the document to have an impact on current plans for the Moon, but this text signs the significance of the ecological approach to governing the space-mining economy (Dent, 2021). Both documents are not legal or political; their value lies in the deep scientific and ethical background needed to guide politicians and lawyers.

Such a brief overview of the academician and civil society impute to the evolving of the legal framework of the space mining sustainable economy leads to the conclusion about the formation of the constant set of legal mechanisms in this sphere. This is not surprising because such working groups often consist of the same representatives. Nevertheless, the multi-stakeholder discussion is valuable according to sheds light on the different aspects (scientific, ecological, economic, ethical, etc.) of the same issue.

Conclusions

The main issues concerning fostering the sustainable development of the space activities on the Moon and other celestial bodies are:

1. The common procedure of advancing governance.
2. Safety zones establishing criteria.
3. Institutionalization of the general recognition of property rights.
4. Benefit-sharing model (based on the resources or facilitation the access to them).
5. Interoperability of the internal authorization procedures and technical standards enabling safe and sustainable space mining activities.
6. Authoritative dispute resolution procedures.

The study of existing legal, ethical, political frameworks and best practices for space mining activities shows that a sustainable development approach is reflected through precautionary measures, establishing requirements of the rational use of the resources, etc.

The great challenge is the bipolarization of the law-making process between the Artemis program and the International Scientific Lunar Station coalition. The main task of the Space Resources Working Groups of the COPUOS. Legal Subcommittee future activities will be to find an average solution acceptable to both in the each from abovementioned issues concerning fostering the sustainable development of the space activities on the Moon and other celestial bodies.

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Space Activities and Sustainable Local Development

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The authors study the impact of space activities on local development and its sustainability. The article focuses on the hypothesis that the benefits of space technology, combining global, regional and local administrative legal instruments, should be applied to build the potential of a given location and improve its economic future and the quality of life of its inhabitants. In the study, philosophical worldview methods (dialectical and idealistic) enable to form philosophical and legal approaches to local development and the regular modern paradigm of public administration of space activities. The scientific novelty of the study is a concept developed for public administration of space activities in the context of their implementation with respect to local development in Ukraine, which envisages the adoption and entry into force of "Road Map for Sustainable Local Development to 2025" with a list of promising directions of space activities development at the local level. The study concludes that local development as a process implies a long-term perspective on the priorities for the future development of the Territories. One such priority is to use the results of space activities for the benefit of local communities.

Keywords: space activities, local development, sustainable development, globalization, public administration, public administrating, law.

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Introduction

To begin with, it should be noted that all practical studies, as well as international initiatives (Exploring, 2020), were aimed at harnessing the potential of space technology at the global (Hay et al., 2006), regional (1st African, 2021) and national (Waswa & Juma, 2012) levels.

However, the impact of space activities on sustainable local development is scarcely studied. Indeed, local development makes an important contribution to national economic performance, which has become more important because of increased global competition, population mobility and technological advances.

The aim of local development is to build the potential of a given location to improve its economic future and the quality of its people's life. Effective local development can reduce inequalities between rich and poor, increase local job created and entrepreneurial activities, increase private sector investment, and improve information flows to investors and developers (Smarter, 2019). Therefore, it would contribute to the achievement of the Sustainable Development Goals.

Therefore, it is already clear that sustainable local development cannot be successful without the maximum involvement of resources, scientists, entrepreneurs, public activists, local self-governments (Tkachuk, 2012: 5). An enabling environment for sustainable local development should be a priority for all these actors; only then will the results be evident, and people will feel a better quality of life.

The various human activities aimed at improving the quality of people's life, as well as the sustainable development of local territories, imply activities related to human mobility. In that regard, space technologies, in particular the Internet, play a special role in supporting various human activities. They provide secure communications and data exchange, navigation and location. Furthermore, the images from space are used for a variety of purposes, including prevention and deterrence of ecological catastrophes.

Furthermore, the use of space technologies, namely information and communication technologies, in all sectors of State and public life is a basic feature of the information society. A new type of State, based on information and communication technology, is commonly referred to as an electronic State. The E-State supports the legislature (E-Parliament), the executive authorities (E-Governing) and the judiciary (E-Court) with information and telecommunications technologies (Administrative, 2018: 210). The introduction of E-Governing in public administration entails qualitatively new forms of organization of the activities of State and local authorities through the involvement of the public in the management of State affairs, using the Internet and interaction with citizens through access to public information resources and the ability to obtain electronic public services (Administrative, 2018: 206).

Therefore, a clear understanding of the value of space technology not only for national defence but also for the general national welfare would enable to establish well-defined perspectives on the strategic development of space activities, to bring people together around the idea of living in space and the sustainable and innovative development of security on Earth using space technology, products, and services (Soroka, 2020a). In addition, space activities will not only be subordinated and respond to global, regional and national priorities in the economy, security, science, and education, but will also have an impact on improving the quality of life of each individual in a given location (Soroka, 2020b). It implies being part of the national doctrine of local development and being part of the international community using international cooperation and collaboration (Soroka, 2021). Indeed, suppose space technology

and services do nothing or will not do anything in the future to improve the quality of life of citizens. In that case, taxpayers should not waste on those activities.

The article will consider philosophical and legal approaches to defining concepts of "space activities" and "sustainable local development." The study indicates that the concept of "development" is a unifying element of the concepts being analysed. It is defined as an idealistic process of transformation of quantitative and qualitative changes initiated by the person (collectives) for a certain improvement of regular phenomena of social synergy.

After conceptualizing "space activities" and "sustainable local development," the article analyses the current paradigm of public administrating of space activities in the context of their implementation in relation to sustainable local development. After all, the world course of development of the theory of management processes testifies to its constant optimization. Without taking into account its changes, it will not be possible to specify a model of effective public administration for sustainable local development in a context of comprehensive dissemination of space technologies and products into our lives.

Finally, considering the role of space technology in the process of local development, in the case of Ukraine, the article proves that legal and regulatory instruments, namely the Road Map for Sustainable Local Development to 2025, should be developed and adopted to provide strategic planning for local public administration in the context of globalization and digitization of public life.

Philosophical and legal approaches to defining concepts of "sustainable development of space activities" and "local development"

The idea of any development is reflected in the principles of history and is one of the leading in the entire history of philosophy, natural and social studies in (Konstantinov, 1967: 454). The literature review shows that the category of "development" has been and remains a subject of study by representatives of many scientific schools and trends: mercantilists, physiocrats, founders of classical political economy, neoclassical economists, representatives of institutionalism, neo-Keynesianism, post-Keynesianism, and scientists of modern trends in the theory of economic (Sita, 2017: 111) and legal development.

By general rule, "development" as a concept is interpreted as changes. Of course, the changes can be positive, expected, or, as we have already found, negative, unexpected (Tkachuk, 2012: 6). From the philosophical perspective on development, it is important to reproduce the common characteristics of the totality of connections and processes of reality and, as a consequence, the advent of a new qualitative state of an object (Kaplina, 2012: 58). In the philosophical dictionary, the concept of "development" is revealed as a natural qualitative change of material and ideal objects, characterized as irreversible and directed (Frolov, 1987: 492). Only the simultaneous presence of all properties distinguishes development from other changes: the turnover of changes characterizes the operation (a constant function cycle); no regularity is characteristic of accidental processes of catastrophic type; without direction, changes cannot accumulate, and therefore, the process loses a single and intrinsic interrelated line (Kaplina, 2012: 58).

We advocate the definition of "development" as the implementation of change for the better, usually in the sense of improving the economic, social, environmental welfare, and quality of life of citizens (Tkachuk, 2012: 6). However, before becoming an integral part of culture, science and economics, this category passed through centuries and eras (Seheda, 2018: 15) in

order to ensure that today's development processes are non-linear, multivariate (alternative), stochastic, unpredictable, characterised by the constructive role of chaos (disorder), the accidental advent of a new (Horlach & Kremen, 2001; Chupov, 2007; Panov, 2011).

Therefore, development is a controversial concept that will never be a single definition, as there will always be different perspectives on what development is and in which direction and how it should be implemented. However, this does not mean that the analysis will not enable us to form our own opinion on its essential understanding.

Therefore, we advocate that the modern philosophical and legal perspective on the category "development" can be expressed as follows: the ideological transformation of quantitative and qualitative changes initiated by the person (collectives) to improve the implementation of regular social life synergies.

Concerning the philosophical and legal analysis of the qualificative "sustainable development" and "space activity," it is necessary to note that the main tasks of the legal regulatory mechanism for the activity at the present stage are: military security, safety of people and the natural environment and achievement of sustainability in the use of outer space in the long term. The three objectives are interlinked and complementary (Hitchens, 2016). Therefore, sustainability or lack thereof is a complex and dynamic feature of communities and regions. It is both a process and an outcome that requires us to be able to anticipate threats, reduce vulnerability, mobilize our resources and assets and plan for a better future (Soroka, 2020b).

The debate on balance between security factors, economic development, and international environmental protection, which began in the 1970s, had not attracted general attention until 1987 when the concept of sustainable development was first introduced in the famous Brundtland report. It stated that development should meet the needs of the present with due regard to the needs of the future generation and further defined sustainable development as development that meets the needs without compromising the ability of future generations to meet their own needs (Report, 1987: 41). The definition includes two key concepts: the concept of "needs," in particular the critical needs of the world's poor, which should be given a priority; and the idea of constraints determined by the State of technology and the ability of the environment to meet present and future needs. Then, the concept of "sustainable development" appeared in various international documents (Report, 1992; Agreements, 1995) and in the scientific literature (Lélé, 1991; Daly, 1990) and was even recognized as a universal principle in the 1990s (Agreement, 1994; Soroka, 2020b).

The global spread of sustainable development, combined with adverse changes in the space environment in the 1990s, attracted the attention of scientists and practitioners (Mikesell, 1994) and the space community. The following issues were raised in the agenda to be resolved: 1) military uses of outer space; 2) mitigation of space debris; 3) regulation of space traffic; 4) long-term exploration and use of outer space; 5) effects of space weather; 5) nuclear pollution 6) radio frequency interference. More importantly, the six issues were more or less related and responded to global, regional, and national needs. But the optimal mechanism to address them, given their impact on local development, was not developed (Soroka, 2020b). Therefore, there is a need to develop a more inclusive concept that covers and addresses all of the above issues.

In turn, "local development" is often interpreted in a broad sense, namely in the context of regional policy (Khosrow-Pour, 2021), the concept itself remains vague. The basis of the local development approach is in its complementarity with three traditional pillars of regional theory and policy: capital and infrastructure policies; migration as an adaptation mechanism; and growth centre strategies.

Examining the potential usefulness of local development as an effective element of regional development policy, William J. Coffey and Mario noted the emergence of local entrepreneurship and the role of the State in stimulating local initiatives. They summarized local development policies in terms of three options containing financial assistance, access to information and social element (Coffey & Polèse, 1985).

Local development is usually understood as a deliberate, systematic activity of the authorities aimed at the development of the territorial community with the aim of stable improvement of the living conditions and living standards of residents (Local, 2012). Such development covers policies and programmes that enable the community to adapt to economic changes in order to improve its competitive position, taking into account decisive factors: human resources; information and technology; capital and infrastructure (Hordieiev, 2012).

At the same time, according to the European community, "local development" is the product of a unique combination of human and material resources that intersect in a certain place. It is a dynamic process categorical essence thereof is three main areas: input and output, and its results (Cohesion, 2010: 10):

a) Input data – for example, community, partnership, endogenous potential;
b) Output data – for example, local beneficiaries, self-help, access to services;
c) Results – for example, collective and shared goods, development, strategic planning, regeneration, efficiency, social innovation, empowerment, legitimacy, well-being, convenience and collective intelligence.

That is, local development is a comprehensive system of change. Their essence is joint coordinated actions of the concerned parties to legal relations aimed at the innovative transformation of economic, social, cultural, and environmental conditions. These are aimed at affirming the basic values of a democratic society in a given locality.

Local development characteristics can be identified as the process, activity and not the State; joint activities of society; a partnership between community and business; the actor of local development is the local community – the people of the territory or several local communities united by common goals; driven by development is factors of local competitive advantages; motivated by the economy; evaluated by meeting the needs of the members of the community, the improvement of the living standards of the population, the growth of living standards (Vasylchenko et al., 2015: 12).

Therefore, the concept of "sustainable development of space activities at the local level" should be an independent element in optimizing all local welfares and resources. It implies that the need for territorial development must be initiated "from the bottom up." Priority should be given to local development programmes based on a national, regional, and global development strategy, taking into account the priorities for the sustainable development of space activities.

The impact of space technology on local development in Ukraine: an administrative and legal aspect

Today, space activities are the driving force of technology for the entire economy, providing jobs and export. In addition, many related technologies and opportunities contribute to a wide range of space and non-space activities. Such opportunities include information and communication technologies, which are effective tools for the digitalization of society as well as for the economic development of local territories. In the coming decades, the old paradigms will give way to a new ones, and the information age will set its priorities (Jayaraman, (1997).

Therefore, an important tool for the development of a digital society in Ukraine is the electronic government (E-Governing), which is people-centered, open to all, and aimed at creating an innovative model for the development of a high-tech society, the main subject of production thereof is information and knowledge-based technologies, that is the results of the intellectual work of citizens (Administrative, 2018: 205).

In Ukraine, at the legislative level, Law 74/98-VR "On the National Informatization Programme" of 4 February 1998 provides for the National Informatization Programme and the strategy for solving the problem of meeting information needs and information support for social and economic, environmental, scientific and technical, defence, national-cultural and other activities in sectors of national importance (On the National, 1998).

The National Informatization Programme includes the Concept of the National Informatization Programme; the Set of State Informatization Programmes; Sectoral Informatization Programmes and Projects; Regional Informatization Programmes and Projects; Local Government Informatization programmes and projects.

Therefore, the National Informatization Programme is a set of interrelated individual informatization tasks (projects) aimed at implementing public policy and priorities for modern information infrastructure in Ukraine. This can be done by concentrating and rationally using financial, logistical and other resources, the productive and scientific-technical potential of the State, as well as by coordinating the activities of State bodies and local self-government, enterprises, institutions and organizations of all forms of ownership and citizens in the field of information technology.

Local self-government informatization programmes and projects are drawn up by these bodies and must comply with the National Informatization Programme and be adopted and implemented with the agreement of the General State customer. The selection of operators for informatization programmes and projects for local authorities is carried out in accordance with the requirements of article 15 of the Law of Ukraine, "On the National Informatization Programme".

On the proposal of the General State Customer, the Cabinet of Ministers of Ukraine may stop the implementation of the informatization programme and project for local self-government bodies in the cases provided for in article 17 of the Law of Ukraine "On the National Informatization Programme" (On the National, 1998). At the same time, specialized Law of Ukraine 280/97-VR "On Local Self-Government in Ukraine" of 21 May 1997, does not specify any powers related to informatization.

Overall, in recent years, the trend regarding the development of E-Governing in Ukrainian cities has been extremely positive, despite the difficult economic and political situation. The effective implementation of E-Governing at the local level needs to develop and adopt the necessary legal and regulatory framework. A variety of electronic administrative services have been successfully offered at the regional and local levels. There is a need to make better use of available human and material resources in the implementation of E-Governing at the local and regional levels. Furthermore, administrative reform processes should be synchronised, primarily decentralising and deconcentrating, with the development of E-Governing at the regional and local levels (Chukut, 2017: 24–26).

Therefore, E-Governing at the local level is an important tool for the development of the information society and the technological development of the territories, and therefore for the active implementation of local E-Governing self-governments should be required to adopt local informatization programmes that specify the tools, plans and time frames for

implementing informatisation of local government. To this end, Law of Ukraine 280/97-VR "On Local Self-Government in Ukraine" of 21 May 1997 should be supplemented with article 27-1 to read as follows:

Article 27-1. Powers in the field of informatization, electronic governing, the formation and use of programmes and projects for the informatization of local self-governments and the development of the information society -

1. The executive bodies of rural, township and city councils set up computer programmes and projects, which are in line with the National Informatization Programme, adopted and implemented with the agreement of the General State Customer, in accordance with the requirements of the Law "On the National Informatization Programme";

2. The executive bodies of rural, township and city councils exercise other powers in the field of information and electronic governing, the set and use of programmes and projects for the informatization of local self-government bodies and the development of the information society, provided for by law (Oksin, 2020).

In addition to their positive impact on the digitalization process of public administration, space information technologies are important for local economic development. For example, ICED specialists proposed a matrix of economic activities, grouping modern sectors of the national economy into four quadrants, considering two key characteristics – high technology and competitiveness – as determinants of the choice of government regulatory instruments to support and stimulate the development of relevant economic activities. As well as the IT industry, the aerospace industry is called "strategic leader" (Ukraine, 2017).

Therefore, local development as a process implies a long-term perspective on the priorities for the future development of the Territories. One such priority is to use the results of space activities for the benefit of local communities. Therefore, we propose to adopt the Road Map for Sustainable Local Development to 2025. It is based on the agreed principles and approaches of the Sustainable Development Goals (The Sustainable, 2015) and the Long-term Sustainable Development of Space Activities (Draft, 2011). The Road Map provides for a set of administrative and legal (organizational, methodological, control) measures to increase the use of the functionalities of public administration of space activities and increase transparency in the relationship between all parties concerned. The Road Map contains both system-wide actions aimed at improving the public nature of space governance (Tzymbal, 2016: 22) at the local level and local development measures.

In Ukraine, the promising areas of space activities development at the local level are (Soroka, 2020b):

1. Preservation of national security and science objectives, taking into account local characteristics.
2. Expansion of space programmes in a top-down direction, taking into account user requirements.
3. Creation and dissemination of knowledge, from basic knowledge to technology transfer to other sectors.
4. Stimulating local business environments that invest in technology and encourage investment, allowing experimentation with new ideas, technologies and business models.
5. Creation of local policies aimed at stimulating innovation in entrepreneurship, with clear tools, grants, procurement mechanisms.
6. Formation of new and support for existing skilled labour force.

Conclusions

Today it becomes clear that the connection between "modern administration" and changes in social values is leading. As a result, the demands and expectations of society from public administration in general and space activities, in particular, are growing. This applies especially to local and regional public administration bodies in terms of the economic and administrative efficiency of the decisions and actions taken, aimed at achieving territorial balance in a context of comprehensive dissemination of and dependence on space technologies.

It is established that the latest concept of public administration of space activities in the context of its realization regarding local development in Ukraine envisages the development and entry into force of the "Road Map for Sustainable Local Development to 2025." This is the first step to the withdrawal of local development from the "shadow" of a regional one. If the development of local road maps for sustainable local development takes into account the latest advances in space activities, this will result in the creation of new jobs and an increase in revenues for local budgets, which in turn will be the key to improving the quality of life of the population. The main areas of strategic local development planning are knowledge and innovation, creativity, diversity and identity, energy efficiency and resource efficiency, environmental friendliness, accessibility and mobility, education and skills.

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Current Trends and Issues of Legal Regulatory Framework for Making Space Policy in Ukraine

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The article studies current issues of the legal regulatory framework for making public policy on space activities. It has been established that the national rocket and space industry is in the deepest institutional and legal crisis caused by ineffective space policy. The focus is on the urgency of the legal optimization of the system of public administration of the space sector and the need for a clear legislative distribution of powers in the field of making space policy. The study proves that organizational and legal changes are required in the space sector through transforming State ownership, privatizing and developing various forms of ownership and business in the space sector of the economy. An important factor in overcoming the sectoral crisis should be the implementation by the State of an adequate regulatory space policy and the identification of legal mechanisms to stimulate an innovative model for space activities. The study reveals the conceptual basis for the implementation of space law reform in Ukraine and makes proposals and recommendations to improve the efficiency of public administration tools in the national space sector.

Keywords: space activities, space law reform, space legislation, corporatization, space policy, rocket and space industry

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Introduction

Space activities are of particular importance in the processes of globalization and informatization of the world community, in the solution of many social and economic problems and research tasks, as well as in ensuring national security and defence. The State has a special

role and place in forming and developing the national space sector (Shemschuchenko & Semenaka, 2021). While determining the areas and priorities of space policy, the State concentrates administrative and financial resources on them.

Making public policy on space activities in Ukraine was entrusted to the State Space Agency of Ukraine (hereinafter referred to as the SSA), a central executive body, directed and coordinated by the Cabinet of Ministers of Ukraine (On Space, 1996). However, the inefficiency of the SSA in fulfilling legally defined functions and tasks in managing the space sector made the State change its organizational and legal status in December 2019. This implied guidance and coordination of SSA activities by the Cabinet of Ministers of Ukraine through the Minister of Economic Development, Trade and Agriculture of Ukraine (hereinafter referred to as the Ministry of Economy) (On the approval, 2014).

The Ministry of Economy was responsible for making domestic space policy, which established a Space Coordination Office within the Department of Economic Security and Defence of the Ministry of Economy. The Office includes the following units: the Department of Space Economy and the Department of International Space Projects (On approval, 2020).

However, as a result of another turbulence in the system of relevant public administration bodies, since September 2020, the Deputy Prime Minister of Ukraine, the Minister for Strategic Industries, has been responsible for space activities (On defining, 2020). Therefore, the unit of the Ministry of Economy – the Office for the Coordination of Space Activities – was excluded from the structure of the Ministry of Economy (On approval № 1085, 2020; On approval № 819, 2020; On the inclusion, 2020; On the structure, 2021).

The newly established Ministry for Strategic Industries of Ukraine is the principal body within the system of central government bodies, which ensures making public policy on space activities. The activities of the SSA are now guided and coordinated by the Cabinet of Ministers of Ukraine through the Deputy Prime Minister of Ukraine, the Minister for Strategic Industries, who make public policy on space activities (On approval № 819, 2020).

In a short period, as we see, the State has fundamentally changed the corresponding scheme for guiding and coordinating the activities of the SSA, which is in fact has lost its powers in the field of sectoral management of the space sector, while retaining only the function of making space policy (Regulations, 2015). However, the absence of an integrated system approach, the disregard for objective factors and fundamental economic and legal principles in the reform of space public administration and its staffing support have further deepened the crisis processes in making space policy.

As a result of the haphazard development of the space legislation, the powers of the Ministry of Education and the SSA are duplicated, and these State bodies' performance lacks coordination in the implementation of sectoral management. It should be determined that the new legal managerial system in the space sector does not meet the needs of the State to ensure effective space reforms.

Legal issues in space public administration

The sustainable development of the national space sector requires the State to implement a pragmatic space policy in the context of a structural and sectoral space policy, to use legal mechanisms for enhancing public administration of the State property, and to support the commercialization of space activities in order to make practical use of space services and technologies in the real economy. These include a set of organizational, economic, financial

and legal measures initiated by the State, aimed at increasing the investment attractiveness of space enterprises and the quantity of output of competitive space products, the efficiency of the production of rocket and space technology.

Sound areas of reform determine effective addressing the problems of the public administration system in the national space sector. Apparently, chaotic political and legal changes in space public administration counter to elements of the constitutional principle of the rule of law such as legal certainty, legal predictability and legitimate expectations. Economic entities in the space sector cannot be sure of their legitimate expectations of the quality and stability of the space legal regulatory mechanism.

Currently, the Ministry for Strategic Industries lacks the potential in the field of strategic planning and making public space policy to get the national space sector out of the crisis. However, its building usually takes a considerable amount of time, which is not the case at present, to solve the established core tasks and functions.

Nowadays, legal optimization and a coherent system of public administration of the space sector are required to ensure space policy efficiency and productivity. Obviously, the technical distribution of powers between the Ministry for Strategic Industries and the SSA will not solve the problem of ensuring a market model for the operation of the space sector. Their solution must be achieved by changing the conceptual approaches and legal basis for making public policy on space activities.

It seems that the best State solution would not be to improve the institutional efficiency of the SSA, strategic planning and operational management, guidance, and coordination of its activities by the Cabinet of Ministers of Ukraine rather than to change the governing body of the space industry. Moreover, it is important to improve the role of the highest body within the system of executive authorities in guiding, coordinating and monitoring the activities of the central executive body, making public policy on space activities. The implementation of the relevant functions of the Cabinet of Ministers of Ukraine should include the definition of clear criteria for evaluating the efficiency of the SSA – ensuring that maximum results are achieved. In addition, evaluation is required to determine the quality and impact of its activities.

Organizational and legal changes in the space sector

It should be noted that the problems of the rocket and space industry are not comprehended at the State level, as well as the need to ensure the restructuring of the space sector – the creation of an economically viable sector, capable of producing competitive space products in a market economy. In particular, it was planned to conduct corporatization of space enterprises, formation of the State Rocket and Space Corporation "Southern Machine Building Plant" on the basis of SE PA Yuzhmash and Yuzhnoye SDO (On measures, 1998).

The space legal regulations of Ukraine identify the need to develop a draft State innovation programme for the development of the space sector (with the introduction of space technologies in industry and the application of a special investment regime for the implementation of the programme) (On measures, 1999).

The Concept for the restructuring and innovative development of the space industry, adopted for implementation, defined the main goal, principles, objectives and paths for the reform of enterprises and the entire industry (On measures, 2001). The Concept was the basis for making the Programme for the restructuring and innovative development of the space industry.

In addition, the Government of Ukraine has determined the tasks and ways of reforming (restructuring) the space sector in the medium term (to 2008) with a view to implementing the main areas of its development and turning it into a highly effective scientific-technological and production complex (On approval № 1455, 2004). The main areas of the reform (restructuring) are improvement of the sectoral system of the State regulatory and managerial mechanism, market transformation, increase of investment attractiveness of enterprises. The corporatization of State-space enterprises was also considered. The Cabinet of Ministers of Ukraine approved a special State programme for the development of the above-mentioned main Ukrainian enterprises for the development and production of rocket and space technology (State, 2009).

To date, however, attempts to restructure the space sector have not been implemented, and this impedes the solution of the problems of the sustainable economic development of the space sector. An effective national space policy requires effective organizational and legal changes in the space sector by transforming State ownership relations, privatization, development of various forms of ownership and business in the space sector of the economy.

In order to ensure a systematic approach to resolving the issue of introducing a modern form of State management of the corporate rights of enterprises in the space sector, the Cabinet of Ministers of Ukraine has now adopted a decision on the reorganization of the legal entities of the rocket and space industry of strategic importance to the economy and security of the State, as follows: State Enterprise M.K. Yangel Yuzhnoye State Design Office, State Research and Production Enterprise "Kommunar Association," State Enterprises Production Association Kyivprylad and A.M. Makarov Production Association Yuzhmash (hereinafter referred to as A.M. Makarov SE PA Yuzhmash) by transforming them (by changing their organizational and legal form) into joint-stock companies, 100% shares thereof belong to the State (On coordinating, 2021). At the same time, the SSA is required to take steps to reorganize the above-mentioned State enterprises in the space sector in accordance with the procedure established by law.

Organization and implementation of the corporatization of State-space enterprises of Ukraine (transformation into joint-stock companies), the introduction of a corporate model for the management of space enterprises should be an indispensable prerequisite for the progressive development of national space activities on a market basis.

It is important that modernized space enterprises with a new managerial system should be able to adapt to new economic conditions and ensure the manufacture of competitive space rocket technology that meets the requirements of the world market for space services and technologies. Moreover, the changes in the space sector require individual structural units out of multidisciplinary space enterprises for their further business activities. In particular, the main State enterprise of the rocket and space machine-building industry – A.M. Makarov SE PA Yuzhmash – should exclude non-core, such as the manufacture of universal tillage tractors, single-section trolleybuses, chassis for aircraft (AN-140, AN-148, AN-158), wind energy installations (VEU 56-100, VEU T-600-48), etc. In other words, the activities of this space enterprise should be focused exclusively on space activities – the production of rocket and space products (launch vehicles, spacecraft, etc.).

Following the completion of the above-mentioned organizational and legal procedures for the reorganization (transformation), financial recovery, and investment attractiveness of the rocket and space industry, the establishment of a legal framework for the organization and implementation of privatization in the space sector should be an important part of the sectoral reform of the space industry. Bearing in mind the long-standing inefficiency of

making, coordinating and implementing of space policy on the development of national space activities and the scarcity of State budgetary resources, the corporatization and privatization of space enterprises seem to be effective instruments for attracting factual foreign and domestic investment, which will contribute to the stable functioning of the relevant economic entities. The contribution of the non-State sector to the structure of the national space sector through an effective private owner will accelerate real economic growth.

Main areas for improving the legal regulatory mechanism for space relations

The development of the entrepreneurial basis of space activities and the enhancement of their competitiveness and the use of private funds for investment in space research and development are of great importance in overcoming the internal and external challenges facing the space industry. The main task of the State in building an effective national space sector is to create favourable organizational, legal, and economic conditions for the establishment and development of space entrepreneurship, which is extremely fragmented, is in its infancy.

In the context of globalization challenges, the strategy of public space policy should be an enabling economic and legal environment for mastering new technologies for the high-technology development of the space sector on a market basis, with the application of State regulation, but where the mechanisms of the market economy are not functioning effectively. That is, market-based economic and legal regulatory methods should be combined with the State regulatory mechanism for the space sector.

In 2019, the State abolished the monopoly of State enterprises and organizations in space activities such as the testing, production and operation of launch vehicles, including their space launches. Nevertheless, in practice, the legislator's deregulation hopes of activating economic entities (enterprises, institutions and organizations) in space activities have not yielded the expected results, since they did not give rise to an entrepreneurial interest.

Over-regulation of relations in the field of space activities (e.g., illogical licensing of its types until 2015) and new legal and administrative barriers established by the State in 2019 for its foundation in the form of permit-declaratory procedures (Procedure for issuing, 2020; Procedure for submitting, 2020) have a negative demotivating effect on the decision-making of economic entities to engage in the space business. As a result of ineffective legal regulatory means, entities of economic relations are inert in starting space activities.

Space legislation should be based on an ideology of freedom to conduct space activities. Enterprises in the space sector of the economy develop, manufacture and operate rocket and space technology on a cooperative basis with foreign space entities. Participation in this relationship is not possible without confirmation of the quality and reliability of space products. That is, within a defined space project, the domestic space entities provide a system of quality management, supervision, and control of related risks in space activities.

It is obvious that the complex of legal issues could be resolved by improving the Ukrainian legislation provisions on the system of standardization and certification of rocket and space technology, without resorting to appropriate administrative measures, which lack convincing legal arguments for their implementation. Accordingly, it is important to take into account subjective and objective trends in need to minimize the administrative burden of State regulatory mechanism for space activities. We advocate that legislative reform could stimulate the development of the space industry on a commercial basis (Recent, 2017).

The process of improving national space legislation should also take into account the actual needs of participants in space relations and the need for economic incentives for economic entities to carry out space activities. Especially, it is important to consider the interests of private players (private interest) (Soroka, 2020).

However, in the absence of economic motivation, the space industry sector could not be expected to improve. With this regard, the implementation of an adequate regulatory space policy by the State and the development and introduction of legal instruments to actively encourage actors to invest in and innovate in space activities are important factors in overcoming the sectoral crisis and the emergence of new and improved space relations. This involves the use by the State of classical space policy regulatory tools such as the granting of tax and customs privileges and State guarantees for the development of promising areas of space activity.

The strategy of public space policy should be an enabling environment for adopting new technologies for the high-technology development of the space sector on a market basis, using State regulatory instruments, but only where the mechanisms of the market economy are of low efficiency. That is, market-based economic and legal regulatory methods should be combined with the State regulatory mechanism for the space sector.

An extremely complex issue that needs to be urgently addressed is the establishment of the latest paradigm of national legal space policy to optimize and increase the cost-efficiency of the space industry. A comprehensive approach to improving the legal regulatory mechanism for space relations, updating the legal means, instruments and space legal regime should become an integral part of the State's space policy in order to preserve and progressively develop the national space sector.

The solution of the above-mentioned range of problems in the development of the space sector is based primarily on the development of a unified and pragmatic space-based legal ideology on the areas of codification of Ukraine's national legislation on space activities, that is, a draft Space Code of Ukraine or systematization, improvement and further development of space legislation: adoption of a new version of the Law "On space activities", special laws of Ukraine on remote sensing of the Earth, satellite navigation, extraction and use of natural resources of celestial bodies and other space legislation.

The use of up-to-date basic and scientific and practical legal knowledge in space law and the results of space legal research applications should guarantee the proper trend in law-making in the space sector, as well as the application of space law. Advantages should be taken of legal developments characterized by innovative solutions to space law problems that are adapted to modern business requirements, reflect the real State of space relations and contain scientific forecasts of trends in the further development of legal regulatory mechanism for space activities.

Conclusions

In order to overcome the negative factors in making space policy, which has led to crisis sectoral phenomena, space law reform in Ukraine is objectively necessary with scientifically sound proposals (recommendations) on resolving current legal issues related to the progressive development of national space legislation and improving the efficiency of State regulation and management of the space sector, its organizational restructuring and commercialization of the results of space activities.

Reform measures should provide for specific instruments to address the problems of technological development in the space sector, introduce market-based regulatory frameworks for space relations and create an investment-friendly space environment, ensure an optimal system of public administration in the field of space activities and improve economic and legal relations in the space sector, etc.

The implementation of a legally sound space law reform will ensure a comprehensive modernization of Ukraine's space legislation aimed at establishing an effective market mechanism for regulating space relations, introducing indigenous space technologies in civil and economic applications, which contributes to meeting the modern needs of society and the State, forming and developing the national market for space services and technologies.

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Information Exposure of Microorganisms to Extremely Low Frequency Electromagnetic Waves: Usefulness for Space Medicine

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The article analyses a number of scientific studies on the effect of geomagnetic fields on microorganisms. The analysis has shown the relevance of studying the information (non-thermal) effect of extremely low frequency electromagnetic waves on biological objects: causative agents of infectious diseases both microbial and viral, in order to inhibit their reproduction. The authors make a hypothesis on the possibility of using the software-hardware complex of spectral correction "biometric resultant spectrum analyser" developed by the Ukrainian Corporation "Information Medicine" to diagnose and correct the health of participants in space missions. Methods of scientific knowledge such as analysis and synthesis, deduction and induction, and the observation method have been used to construct the hypothesis. In addition, the work has used analytical and statistical data of the NASA, Committee on Creating a Vision for Space Medicine During Travel Beyond Earth Orbit regarding the morbidity of astronauts during their stay in space. In addition, the results of scientific experiments by Odesa Centre "Information Medicine," Corporation "Information Medicine" and I.I. Mechnikov Ukrainian Research Institute against Plague regarding the effects on strains of microorganisms and viruses by ultra-low power electromagnetic auto-spectral fields in the range of extremely low frequency waves have been applied.

Keywords: information medicine, microorganisms, electromagnetic fields of spherical power, extremely low frequency waves, space medicine, bioresonance.

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Introduction

Today, we live in a context of the global transformation of all spheres of human activities. The influence of technological factors and the results of the scientific and technological development of civilization require the development of new approaches to setting goals for the improvement of public health.

It is important to recognise that the problem of COVID-19 proliferation has posed new challenges to the world community, including space medicine. The significance of the issue raised could be proved by the topics discussed at United Nations meetings. For example, the report of the Scientific and Technical Subcommittee of COPUOS on its fifty-eighth session, held in Vienna from 19 to 30 April 2021 (Benefits, 2021), discussed the use of space medicine and space technology in combating COVID-19.

As the pandemic continues to spread around the world, it is of interest what will happen if such a virus or a similar virus spreads in space.

In this context, the health and safety of astronauts during the entire flight is a major concern of manned space missions and a major concern in space medicine. The longer stay of astronauts in space, the more challenges for space medicine to provide optimal medical care to the first (and subsequent) astronauts who will go on research missions to Mars.

Therefore, the risk of harm from medical events increases with the duration of space missions. It should be noted that the risks to the health of astronauts (e.g., skin diseases, respiratory and digestive disorders) (Safe, 2001) are real and anticipated. The anticipated risks can be predicted considering clinical studies of previous space missions and studies conducted in long-term submarine (Thomas et al., 2000) missions and in the Antarctic environment (Sullivan & Gormley, 1999). Of course, long-term space missions like flights to Mars cannot rely entirely on results from Earth. However, the risks to the health of astronauts in such missions can be minimized.

Therefore, the diagnosis and treatment of the most common mild and serious diseases and injuries expected to occur in the Earth's environment require available resources. As well as the diagnosis and treatment of conditions that are unique to microgravity and a specific space mission require them (Romanenko et al., 2017). The crew must be prepared to treat a wide diversity of conditions of varying gravity during space flight and, above all, be prepared to provide medical assistance in the absence of a rapid return to Earth.

The study is the non-thermal (information) effect of extremely low frequency electromagnetic waves on biological objects: causative agents of infectious diseases, both microbial and viral, in order to inhibit their reproduction, especially in space flight. For the first time, information balance of all organs and systems can be achieved in a contactless manner, at the cell level, with a positive and sustainable therapeutic effect in all clinical application areas using information-wave therapy (IWT). IWT is a new step in medicine development based on the latest advances in space devices and advanced knowledge in medicine, biophysics, and cybernetics.

In the open press, we have not found studies on the effect of auto-spectral fields in the range of extremely low frequency waves on microorganisms and viruses. Such research has been enabled by the introduction of a new class of devices capable of recording and reproducing ultra-low-power electromagnetic fields in the range of extremely low frequency waves. Such devices include a software-hardware complex of spectral correction "biometric resultant spectrum analyser" (Apparatus "KSK-BARS") (Patent, 2007; RF Patent, 2008).

The theoretical basis for effects of electromagnetic radiation on microorganisms

The birth of life on Earth took place against the backdrop of complex electromagnetic radiation. In the evolution of living organisms, the effect of their exposure to the electric, magnetic and electromagnetic fields has been enormous.

Electromagnetic fields are complex because they can propagate in a vacuum without a material environment, where they behave as waves and as particles (Dirac, 1927; Einstein, 1951), and they are inextricably linked to the manner of the space-time continuum (Einstein, 2016; Brodie; 2019).

Lots of data are available on the effect of geomagnetic fields (GMF) on microorganisms (Bauer et al., 1989; Chuvaev, 1969; Kovaleva, 2009a; Kovaleva, 2009b). The stimulation of metabolism and growth of microbial cells was observed under the exposure to a constant magnetic field (Kudo et al., 1993; Makarevich, 1999), and some types of electrical/magnetic fields support the functionality and adaptability of cells and organisms (Romanenko et al., 2017).

The electromagnetic characteristics (or condition) of a cell are one of the driving forces in the life cycle of a cell (Romanenko et al., 2017). At different frequencies, biochemical processes can both accelerate and slow down, which in turn affects the growth of microorganism colonies. At certain frequencies, their growth is completely suppressed, up to the death of the colonies, and in other cases stimulated. This process is poorly managed due to multiple factors (signal frequency, temperature, microorganism growth phase, etc.) (Kovaleva, 2009c; Gretz et al., 1989; Matronchik et al., 1996; Alaverdian et al., 1996).

However, despite extensive research in this area in different countries, the main experiments on the effects of the electromagnetic field on biological objects are in the following bands: constant and low frequency fields (up to a metre of wavelength range), ultra-high – UHF-range (metre, decimetre, and centimetre waves), extremely high – EHF-range (millimetre waves), and sub-millimetre waves.

Despite the importance of electric fields and associated flux of various charged atoms and molecules, as well as the movement of polar molecules in the life cycle of any cell and living organism, nature uses only a fraction of the electromagnetic spectrum. Indeed, the static (resting membrane potential) and alternating (e.g. AP) electric field are in the range of just a couple of kilohertz. However, Fröhlich makes theoretical predictions of the existence of megahertz to terahertz oscillations in living cells (Fröhlich, 1969; Romanenko et al., 2017).

To date, many studies of the effect of EMR in the low-millimetre (non-thermal) intensity (EHF radiation) range on microorganisms exists (Gretz et al., 1989; Matronchik et al., 1996; Alaverdian et al., 1996). Electromagnetic fields in all frequency bands affect living organisms to varying degrees. The effect on various physiological processes and properties in microorganisms is described: cellular division, morphological features, growth rate, biomass

output, enzymatic activity, etc. (Krytsyn, 2009; Tambiev et al., 2003; Kovaleva, 2009c; Gretz et al., 1989; Matronchik et al., 1996; Alaverdian et al., 1996; Katorgin et al., 2020). Some researchers have found high sensitivity of different microorganisms to weak fields (Katorgin et al., 2020; Baranskii & Gaidar, 2007), but no reliable results are given.

The local and global distribution of polyantibiotic-resistant pathogens of nosocomial and opportunistic infections, including methicilin-resistant *S. aureus* (MRSA) and coagulase-negative staphylococcus (MR-CNS), is a serious problem of modern medicine (Kutsyk, 2008). In this context, the search for new potential targets for antimicrobial therapy in staphylococcus cells is relevant (Kovaleva, 2009c; Kutsyk, 2008).

Many authors who have studied microorganisms in the EHF ranges recorded effects on morphological features, changes in cell hydration, enzyme activity (Gretz et al., 1989; Matronchik et al., 1996; Alaverdian et al., 1996; Krytsyn, 2009; Tambiev et al., 2003; Kovaleva, 2009c; Katorgin et al., 2020). The increased enzyme activity of bacterial antioxidant protection under the influence of EHF EMR is associated with the launch of certain mechanisms of biochemical reactions under the action of resonant frequency waves (Bogomolnyi et al., 2014). According to these authors, the effects of EHF electromagnetic fields with ultra-low power are informative in nature.

In certain "frequency and amplitude windows," there is a detectable reaction of the bio-object, and outside of their ranges, there is no such response. The frequency of exposure is the most informative, while the amplitude determines only the body response mechanism (Kholodov, 1972). For example, Fröhlich's theory assumes the importance of the frequency of external stimulus due to the condensation of long-range coherent states in a single mode. This concept was confirmed by experimental observations by Grundler (Fröhlich & Kremer, 1983; Grundler & Keilmann, 1983), in which, at the yeast growth rate was influenced by low radiation of 42 GHz. The resonant band was only 8 MHz (Smolyanskaya & Vilenskaya, 1974; Romanenko et al., 2017). These results led to the above-mentioned concept of a "frequency and amplitude windows," indicating the existence of a resonant effect in biological systems exposed to megahertz and terahertz radiation.

Bio-efficient frequencies are detected experimentally and explained by the possible resonance between the oscillations of the external EMF and their own oscillations (Butukhanov, 2010).

DNA/RNA, like all polar molecules, are very sensitive to frequency. Every DNA molecule has its own resonance frequency. Ultimately, the more primitive the living substance, the lower its resonant frequency (Bogomolnyi et al., 2014). Each living cell carries DNA molecules. Moreover, the same cells have analogous DNA with a similar resonant frequency. When cells are exposed to a resonant frequency of sufficient power, they simply collapse. For example, the infusoria slipper (*Paramecium caudatum*) was destroyed at 1150 Hz (Bogomolnyi et al., 2014), while other authors deny this effect and similar effects on bacteria and viruses as impossible (The ALSUntangled, 2014).

The specificities of the resonant effects can be explained by theoretical and experimental studies led by Peter Gariaev. According to the authors, DNA decay occurred during exposure to laser light spectra. The authors argue that the primary code hierarchy of biological systems is the extracellular matrix (ECM) infrastructure of the cytomembranes, the cytoskeleton and the cell nucleus. Information is exchanged between them in an epigenetic mode via physical channels of non-linear acoustic and electromagnetic oscillations (Gariaev, 1997; Gariaev, 2009)

Specific effects on microorganisms by the Apparatus "KSK-BARS"

With regard to studies on the impact of the information (non-thermal) action of extremely low frequency electromagnetic waves on biological objects, causative agents of infectious diseases both microbial and viral, in order to inhibit their reproduction, they have been carried out in a number of scientific institutes of Ukraine. For example, such research was carried out by the Odesa Centre "Information Medicine" together with the Corporation "Information Medicine" and I.I. Mechnikov Ukrainian Research Institute against Plague using software-hardware complex of spectral correction "biometric resultant spectrum analyser."

Scientists have identified that ultra-low-power electromagnetic auto-spectral fields in the range of extremely low frequency waves have effects on the growth and reproduction of the strains of microorganisms and viruses (Staphylococcus aureus ATCC 25923, Staphylococcus aureus 2781, Escherichia coli ATCC 25922, influenza virus A/Hong Kong/1/68 (H3N2)) (Bogomolnyi et al., 2014).

Furthermore, the proposed patented "method for identifying spectral characteristics of biological and non-living objects and for correcting them" (method for identification and correction) (Patent, 2007; RF Patent, 2008) used in the Apparatus "KSK-BARS" enables to carry out medication testing. The diagnostic system records the frequency characteristics of any medicine (substance) and makes a computer comparison based on the spectral characteristics of all preparations available in the computer's memory with the characteristics of the pathological process, thus identifying the most effective medicine.

The Apparatus "KSK-BARS" is based on the ideology of working not with entire cells, organs and biological organism, but with specific information states of these cells, organs and integral biological objects. Moreover, using the theory of state, interaction and development of such information systems, the Apparatus "KSK-BARS" implies the idea of continuously interacting information systems by Bernhard Riemann (Monastyrskii, 1979) and non-stationary space-time continuum by Nikolai Lobachevskyi (Kotelnikov, 1927).

The method for identification and correction is currently one of the most sensitive and accurate methods of monitoring the human condition. The Apparatus "KSK-BARS" enables to (Figure 1 below):

a) Detect diseases before clinical manifestations;
b) Determine pathogens location while identifying them;
c) Minimize the examination time extremely;
d) Successfully implement prophylaxis and treatment, both on an outpatient basis and at home;
e) Determine precisely immune system condition;
f) Pick up an optimal diet according to the needs of the organism, as well as select medicines, food additives;
g) Effectively select and recommend the right treatment;
h) Determine the sensitivity of identified microflora to medicines;
i) Carry out quality analysis of food products, medicines, food additives, organic and inorganic materials, and much more.

Figure 1

Visual diagram of the sequence of pickup and conversion of the electromagnetic signal from the patient using "KSK-BARS" Apparatus.

Therefore, even considering that it is officially announced that ISS Crew Surgeons has many handled medical conditions on orbit; including skin rashes, abscesses, lacerations, and ST-T segment EKG changes (Jones, 2021), it can be stated that with the help of Apparatus "KSK-BARS" most of these diseases could have been prevented.

Today Apparatus "KSK-BARS" is one of the most effective methods of the last generation of diagnosis and treatment of a number of diseases of a living organism. It is a kind of mobile "polyclinic," which detects the state of vital processes in a specific period and performs correction of the organism. Moreover, the results obtained by scientists, with regard to the information-wave effect on microorganisms using the Apparatus "KSK-BARS," indicate the need for further research in this area.

Conclusions

Microorganisms sent into space can damage astronauts' health and cause life-support equipment to malfunction. Moreover, it is necessary to avoid "reverse pollution," that is, to prevent a return to Earth together with spacecraft. This is because studies have shown that mutated microorganisms can pose a threat to life on Earth.

Therefore, it is timely and appropriate to seek new strategic approaches in methods against microorganisms in the treatment of infectious diseases. Such an innovative method could be to use non-thermal (information) electromagnetic extremely low frequency waves on biological objects: causative agents of infectious diseases both microbial and viral, in order to inhibit their reproduction, using a software-hardware complex of spectral correction "KSK-BARS."

In addition, this method can be used as a basis for the treatment of participants in space missions as an alternative to antibacterial and antiviral therapy by non-pharmaceutic means.

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