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INVESTMENT OPPORTUNITIES FOR INFRASTRUCTURE INNOVATIONS IN UKRAINE

Industrialization and digitalization of all spheres of the economy set the pace of development. The implementation of the latest achievements in related areas of the economy contributes to the innovative development of the country and its businesses. The proposed and economically substantiated innovative project for the production of unmanned aerial vehicles (UAVs) for infrastructure purposes at the existing enterprise of Ukraine allowed demonstrating the economic feasibility of such an idea. The calculation of investment support for the implementation of an innovative infrastructure project has shown that Ukraine has prospects for the development of infrastructure innovations, taking into account global trends in the production of complex technical systems. The calculation of scenarios for the development of an innovative infrastructure project for the introduction of information technology in the economic environment allowed to indicate the probability of taking into account the risks, which will further contribute to the development of development strategies of the company. The use of tools for evaluating venture projects demonstrates the growth of the value of the company implementing the innovative project and is a clear confirmation of the feasibility of implementing an innovative project for the production of UAVs for infrastructure purposes.

Keywords: investments, infrastructural innovations, innovative project, informatization of the economy, production of unmanned aerial vehicles.

Introduction. Innovative development encourages countries, society, businesses to find new, promising areas of activity, free and underdeveloped niches. Constant monitoring of the innovative business environment for existing companies and the study of market opportunities for new businesses require significant financial resources, professional staff, and time. The current state of development of the domestic economy has two aspects: positive and negative. The downward nature of key macroeconomic indicators does not add optimism to modern business, however, is a catalyst for finding new opportunities for development. And the fact that Ukraine belongs to the countries with developing economies, allows adopting advanced technologies, experience, knowledge from more developed countries, to adapt to domestic realities and to improve [1].

The issue of investment support for business activities always arises as a challenge that requires a strategic vision of business development. The production of unmanned aerial vehicles (UAVs) and their commercial use is very promising and profitable. In Ukraine, it is only gaining popularity, is actively used mainly in agriculture, to some extent in energy and infrastructure (transport, construction).

Research analysis and problem definition. Research interest in the use of UAVs in the civil sphere has been demonstrated by domestic and foreign scientists and demonstrated the diverse nature of these studies: from legal support for the use of UAVs in the civilian sphere to certain aspects of the use of multifunctional UAVs for civilian purposes. However, almost no attention is paid to the economic bloc. The object of scientific research is in the plane of innovative economic development, so it is worth highlighting the works of such domestic scientists as T. Nagachevskaya and O. Prygara, who paid attention to modeling the innovative development of the enterprise. They offered practical recommendations for the formation of a model of innovative development of a modern enterprise that could compete in the market [2]. The issues of investment support for the establishment of the enterprise as a business entity were considered in the works of Chervanyov D., Shynkaruk L. & others [3, 4].

Trubia, S., and others have explored how to use UAVs to maintain existing infrastructure to improve quality of life. The authors draw attention to the cost component of such a process and to the growth of the UAV market in the civilian sphere in the next decade [5]. A thorough analysis of the possibilities for the use of drones in infrastructure and the challenges that arise in this case was conducted by Fan, J. & Saadeghvaziri, M. Ala and identified promising directions for the development of the drone market in the world [6].The use of artificial intelligence, intelligent transport solutions and smart information and communication technologies will, in the future, become the core of smart cities. And it is in this system that UAVs have a place, as considered in their study by Pau, G., Severino, A. and Canale, A. [7].

The purpose of the article is to substantiate the investment opportunities for the establishment of an enterprise for the production of unmanned aerial vehicles for infrastructure purposes.

Research methodology. The research used methods of analysis and synthesis (to highlight the main benefits of using UAVs), causation (to identify the preconditions in the domestic infrastructure), system, historical and logical

analysis (to identify features of the evolutionary development of the industry economics), the method of analogies (for the development of an innovative project for the production of unmanned aerial vehicles for infrastructure purposes), dynamic methods for evaluating investment projects (to justify the feasibility of implementing an innovative project for the production of unmanned aerial vehicles for infrastructure purposes), the method of analyzing development scenarios (to assess the risk of a project by establishing the impact on the project of simultaneous variation of several factors due to the probability of each scenario). These methods allowed us to scientifically substantiate and evaluate the investment opportunities of the UAV production project in Ukraine, to summarize the results of the study, taking into account the world experience and the results of scientific research of domestic and foreign scientists and practitioners.

Conducting research and results. The Industrial Revolution, digitalization, and innovation contributed to active economic development. Today, companies operating in various sectors of the economy have a unique opportunity to realize their potential thanks to the digital revolution and to become leaders in domestic markets and look worthy in the international arena. The use of unmanned aerial vehicles in various industries, including energy, roads, railways, and the oil and gas sector, will help solve many problems and challenges. In these industries, companies manage complex assets located in large areas. The main areas of application of drones in the infrastructure sector are investment monitoring, maintenance, asset inventory [8].

If we analyze the benefits of using UAVs for future customers in the main areas of the application of drones, we can note the importance and prospects of this idea (Table 1).

***Table* 1. Analysis of the use of UAVs in the pre-investment and investment phases of the life cycle of the investment project**

Use of UAVs for monitoring planning and implementation of investment projects		
Difficulty	***UAV solution***	***Benefits for the client***
Outdated and poor-quality information about the zero cycle	Obtaining video data from UAVs, integration, and data processing (photogrammetry)	Analytical reports based on high-quality technical products (orthophotos, numerical terrain models, 3D models) that provide an up-to-date understanding of the current situation
Unsystematized documentation	Monitoring the current condition of facilities and preventing future damage through planned UAV operations (flights)	The detailed image and description of the investment object provide sufficient evidence to make claims to the contractor
Project delay		Early detection of problems will reduce the backlog of projects and minimize the risks of additional costs, as well as improve the process of finding contractors
Unscrupulous contractors		
Inaccuracy of estimation at technical acceptance of object	UAV operations on objects that are inspected to confirm the proper nature of the work performed	Accurate documentation that can be used in maintenance. Flights with thermal and optical sensors can detect almost all defects before installation
The need for prompt access to data	Data presentation tool – a special application	Quick access to the results ensures the efficiency of further data processing. Data integration of geographic information systems and CAD
Use of UAVs in key areas of maintenance		
Difficulty	***UAV solution***	***Benefits for the client***
Lack of relevant information	Scheduled diagnostics of power line towers and relevant measuring instruments, pipelines, solar panels, wind power plants, exhaust pipes, cooling towers, etc	Detailed surveys and descriptions of entire sectors with infrastructure will minimize the risk of breakdowns and reduce possible losses
Remote location of infrastructure objects		Early detection of problems with infrastructure in relatively remote areas and planning of necessary repairs
Accidents during inspections	UAVs perform human work.	Improving the safety of inspectors. People can stay on the ground without climbing
Low quality of contractors	Diagnosis of the work of contractors involved in infrastructure maintenance	Reducing the risk of fines, additional costs, and project delays due to the poor quality of contractors
Use of UAVs in inventory of dispersed assets		
Difficulty	***UAV solution***	***Benefits for the client***
Low-quality documentation of distributed assets	Inventory of assets (power lines, transformers)	Improving the quality of documentation of network elements: objectivity; accelerated creation of digital asset registers
High inventory costs in hard-to-reach areas	Verification of assets, such as determining the location and size of supports, etc	Reducing the time of the inventory (checking the availability of property) in large areas and hard-to-reach areas
High labor costs to control the intersection of power lines with the forest (in energy)	Identify specific places where this intersection is likely to occur soon	Prevent damage by cutting down trees before there will be an intersection

Source: systematized by the author.

With the development of image processing technologies, companies can analyze data much faster and more accurately. With the help of UAVs, companies can reduce their costs and speed up the whole process of various works. Workers' safety in the workplace is increased, as UAVs can penetrate hard-to-reach places without endangering the lives of workers.

The study of the European Bank for Reconstruction and Development "Disruptive technology and innovation in transport" analyzes the role and importance of drones through their impact on the country's transport policy (Table 2).

***Table* 2. Policy objectives**

Policy objectives		Transport efficiency							Safety and security			Environment and climate change				Socio-econ					
Disruptive technologies applications		Congestion reduction	Inter-urban corridors	Urban mobility	Accessibility	Strategic planning	Freight transport	Public transp	Safety	Freight transport security	Public transport security	Environmental impact	Energy savings	Fuel savings	Air quality	Labour market	Efficiency/time savings	Productivity	Cost savings	Competitiveness	Economic output
Drones																					
1	Drones – logistics	■	■	■	■		■					■	■	■	■	▒	■	■	■	■	■
1	Drones – traffic monitoring	■	■	■		■	■	■	■			■	■	■	■	▒	■	■	■	■	■
1	Drones – disaster response				■				■								■		■		
2	Drones – asset and construction site monitoring				■				■			■	■	■	■	▒	■	■	■	■	■
2	Drones – building information modeling data				■				■				■	■	■	■	■	■	■		■

■ - Major impact
▒ - Minor impact

1 - technologies that are currently under testing or development, limited implementation.
2 - technologies are implemented on a small scale, require further development

Source: systematized on the basis of 6.

The proposed project is focused primarily on the domestic market, as in Ukraine, UAVs for infrastructure is just beginning to gain popularity. Thanks to the existence of the aerospace cluster "Mechanotronics" (Kharkov), where there are highly qualified personnel for enterprises in the aerospace industry, it is possible to implement the proposed business idea [10]. There are also about 70 IT companies in Kharkiv that have formed a cluster. This will help involve IT, professionals, to develop software for UAV processes. The prospects of this idea are that, as a result of this project, the new company has a real opportunity to become the first Ukrainian company to manufacture high-performance, high-quality, and innovative UAV complex for infrastructure.

The main activity of the enterprise is the activity for production of UAVs; advising on the implementation of solutions using UAVs for a specific industry; data analysis, data processing (development of geospatial products, orthophotos), and interpretation about costs and operational efficiency; service.

To substantiate the investment project for the production of unmanned aerial vehicles for infrastructure purposes, it is necessary to carefully approach the choice of the discount rate, because, in conditions of high instability of the Ukrainian economy, it cannot be calculated by standard methods used in foreign practice. We use the method of calculating the discount rate for the case of venture capital – CAPM, where we evaluate the following indicators: risk-free rate of return, β-ratio, and risk premiums. The final value of the discount rate by the CAPM method was 23 %.

***Table* 3. Calculation of project economic efficiency indicators, thousand UAH**

Indicators	Years					
	2020	2021	2022	2023	2024	2025
The amount of investment, Inv	4 500					
Discount rate, r= CAPM	23 %					
Net cash flow, CF	2 952,75	3 647,25	3 809,13	3 804,63	3 822,13	3 802,13
Accumulated cash flow	–1547,25	2100	5909,13	9713,75	13535,9	17338
Payback period of the project, PP	1,5 years					
Discounted cash flow, DCF	2400,61	2410,77	2410,77	1662,23	1357,62	1097,98
Net present value, NPV	–2099,39	311,38	2722,14	4384,38	5741,99	6839,98
Profitability index, PI	1,52					
Internal rate of return, IRR	72,56 %					
Discounted payback period, DPP	1,9 years					

Source: calculated by the author.

The initial data for the project substantiation were calculated in the course of the research and are based on empirical data of expenses and receipts of cash flows at the enterprises of civil aviation of the Ukrainian economy.

Thus, the evaluation of the efficiency of the investment project showed that it is investment attractive.

Taking into account the risk of the project using scenario analysis methods (Table 4) shows that in the pessimistic scenario – a decline in demand for products, high competition in the market, resulting in reduced sales, and for the optimistic scenario – an increase in demand for the company's products, leading positions in the market, increase in sales.

***Table* 4. Project scenario indicators, UAH**

Indicators	Scenario		
	Pessimistic	Base	Optimistic
Discount rate, %	23		
Period of calculation of integrated indicators, years	6		
Total amount of income, UAH	14 558 667	21 838 000	28 389 400
Total amount of expenses, UAH	5 500 000	4 500 000	4 000 000
NPV	*1 817 451,68*	*6 839 982,8*	*10 269 030,8*
PI	*0,33*	*1,52*	*2,56*

Source: calculated by the author.

The assessment of the probabilities of scenario development and the calculation of the average expected value $\overline{NPV}$ showed a fairly high level of risk (Table 5). Quantitative risk assessment is 42.65 %.

***Table* 5. Expected effect of project development scenarios, thousand UAH**

Scenario	Probability	NPV
Base	0,5	6 839 982,8
Optimistic	0,3	10 269 030,8
Pessimistic	0,2	1 817 451,68

Source: calculated by the author.

For a complete presentation, it is worth assessing the value of the company implementing this innovative project, because these investments have all the hallmarks of a venture. So, let's use the most commonly used methods of valuing startups: the method of discounted cash flows, the Berkus method, the First Chicago method, and the method of summation of risk factors.

The method of discounted cash flows.

The method of discounting cash flows is based on an estimate of the cash flows of the startup, whence it got its name. Above we have already determined the expected cash flows of the startup, after which we calculated the discount rate for the model CAPM. Given the rapid growth rate of the market for unmanned aerial vehicles in the world, and expecting high growth rates of the company in Ukraine, we choose to calculate the growth rate of 15 % [11].

$$PV = DCF_1 + \cdots + DCFn + TV,$$

$$TV = \frac{CF_{n+1}}{r - g}$$

g – the expected growth rate of the company is 15 %.

$$TV = \frac{6\,500\,450}{0{,}23 - 0{,}15} = 6\,875\,562.5$$

$$PV = 18\,215\,544.9$$

Berkus method.

The basis of this method is to take into account the potential of the startup with the help of empirical coefficients to the recovery method, or through evaluation in comparison with a similar project.

The method has low accuracy, and the assessment by different investors may vary, examples of the following coefficients:

- Surcharge for the viability of the idea of 40 %;
- Surcharge for the implemented prototype 30 %;
- Surcharge for the effectiveness of the management team 20 %;
- Allowance for strategic relations 10 %;
- Surcharge for the issue or sale of 20 %.

Let's start with the value of the company, namely investments for UAH 4 500 000. Now let's calculate the potential of a startup and its cost according to the Bercus method.

***Table* 6. Calculation of the value of the company by the method of Berkus, UAH**

Elements of a startup	Value for the project
The perspective of the idea	1 800 000
Implemented prototype	1 350 000
The effectiveness of the management team	900 000
Strategic relations	450 000
Product release or sale	900 000
Sum	5 400 000

Source: calculated by the author.

The cost of the company is UAH 9 900 000.

The First Chicago method

This approach allows taking into account the probability of different results, which is especially relevant for the case of evaluation of startups, which are characterized by special uncertainty. Based on subjective considerations, we assume that the probability of an optimistic result is 20 %, realistic – 50 %, and pessimistic – 30 %.

***Table* 7. Calculation of the value of the company by the First Chicago method, UAH, %**

	Result		
	Optimistic	Optimistic	Optimistic
Probability	20 %	50 %	30 %
Expected cost	16 454`221	14 243`951	4 026`207

Source: calculated by the author.

According to this method, the cost of the company will be UAH 11 620 681.

The method of summation of risk factors.

The risk factor summation method or the RFS method is a more in-depth version of the Berkus method. First of all, determine the initial cost of the business. Then set the specified cost for the 12 risk factors inherent in startups at the development stage:

***Table* 8. Calculation of the company's value by the RFS method, UAH**

Initial cost			7 000 000
1. Management risk	Very low	+ 300 000	
2. Stage of business	Average		7 300 000
3. Legislative/political risks	Very high	– 600 000	6 700 000
4. Production risks	Average		
5. Risks of sales and production	Average		
6. Risk of financing / raising capital	Average		
7. Competition risk	Low	+ 400 000	7 100 000
8. Technological risk	Low	+ 250 000	7 350 000
9. Risk of litigation	Very low	+ 500 000	7 850 000
10. International risks	Average		
11. Reputational risks	Very low	+ 500 000	8 350 000
12. Potentially profitable way out	Very high	+ 500 000	8 850 000
Business evaluation			8 850 000

Source: calculated by the author.

The initial value is defined as the average for a similar business in your area. The most difficult task for this method, as for most similar evaluation methods, is to find information about such startups. The RFS method is intended for startups that are in the early stages of development.

Conclusions and perspectives of further research. According to Gartner, by 2020 the turnover of the global UAV market will exceed 11.2 billion dollars [12]. According to analysts at J'son & Partners Consulting, in 2017, military drones held 53 % of the market in monetary terms and only 0.5 % in kind/ This significant difference is since combat drones are on average 200 times more expensive than civilian UAVs (consumer and commercial). In 2017, the share of the first segment was estimated by J'son & Partners Consulting at 23 % in cash and 84 % in kind. The second – 24 % and 15 % respectively.

The consumer segment is already close to saturation, and the industrial segment is just beginning to gain the attention of corporations. In the next few years, the industry will develop, primarily due to the industrial segment, and it will account for more than 80 % of the total UAV market [13].

Regarding the statistics of the world market of commercial UAVs, the first place is occupied by infrastructure; the second is agriculture; third – transport; fourth – security; fifth – media and entertainment; sixth – insurance; seventh – telecommunications and eighth – mining [13].

So far, 93 % of the market is held by foreign players. As all over the world, the first place is occupied by DJI. According to various estimates, its share in Ukraine reaches about 70–85 % of the market. Why so much? Because DJI representatives just came up with a segment of consumer drones called RTF – ready-to-fly. The French brand Pa rrot took the second position, thanks to the creation of the direction of industrial solutions popular with Ukrainian farmers.

Domestic companies also began to quickly develop a promising niche [14]. Over the years, more than 10 companies have joined the development of military and civilian drones: Antonov, Athlon Avia, Politeco-Aero, DeViRo, Meridian, UA Technology, Ukrspecsystems, Carboline, DroneUA, Spaitech, Kray Technologies, Aytek. Ukrainian manufacturers of civilian drones occupy about 7 % of the domestic market.

Thus, taking into account the prospects for the development of unmanned aerial vehicles in Ukraine, using state support, it is proposed to perform the following measures:

1. Conduct an economic assessment of the possibility of purchasing (abroad) UAVs and self-manufacturing BPAC components.

2. Develop a strategy for the development of UAVs, the so-called UAV roadmap, the main purpose of which would be to prepare answers to the following three key questions: – what are the potential challenges that UAVs can solve; – what equipment and technologies are needed for this; – in what terms these technologies can be realized.

3. Based on global experience in the production of complex technical systems, the implementation of the domestic BPAC project requires the development of a state target program that determines the parent company, participants, timing of the project, the amount of necessary funding.

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ІНВЕСТИЦІЙНІ МОЖЛИВОСТІ ІНФРАСТРУКТУРНИХ ІННОВАЦІЙ В УКРАЇНІ

Обґрунтування реалізації інноваційного проєкту з виробництва комплексів безпілотних літальних апаратів інфраструктурного призначення на діючому підприємстві України. Розрахунок інвестиційного забезпечення для реалізації інноваційного проєкту інфраструктурного призначення. Інновації інфраструктурного характеру, які сприятимуть цифровізації економіки та освоєння нових ринків.

Ключові слова: інвестиції, інфраструктурні інновації, інноваційний проєкт, виробництво безпілотних літальних апаратів.

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ИНВЕСТИЦИОННЫЕ ВОЗМОЖНОСТИ ИНФРАСТРУКТУРНЫХ ИННОВАЦИЙ В УКРАИНЕ

Обоснование реализации инновационного проекта по производству комплексов беспилотных летательных аппаратов инфраструктурного назначения на действующем предприятии Украины. Расчет инвестиционного обеспечения для реализации инновационного проекта инфраструктурного назначения. Инновации инфраструктурного характера, способствующие цифровизации экономики и освоения новых рынков.

Ключевые слова: инвестиции, инфраструктурные инновации, инновационный проект, производство беспилотных летательных аппаратов.

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ОЦІНЮВАННЯ ГІБРИДНОЇ НЕОКЕЙНСІАНСЬКОЇ КРИВОЇ ФІЛЛІПСА ДЛЯ УКРАЇНИ

Присвячено економетричному тестуванню гібридної неокейнсіанської кривої Філліпса (модель ціноутворення Кальво) для України за період 2016–2020 років. У дослідженні порівнюється використання таких ступенів ділової активності, як граничні витрати на працю та розрив ВВП. Метою дослідження є визначення ступеня впливу раціональних та адаптивних інфляційних очікувань на динаміку інфляції в Україні. Результати оцінювання демонструють, що інфляція має стійку інерцію через домінування ретроспективної компоненти. Також виявлено, що ступінь цінової жорсткості в Україні є досить низьким, тоді як частка фірм, що використовують виключно історичну інформацію в процесі встановлення цін, є досить високою. Результати дослідження розширюють інструментарій планування та реалізації грошово-кредитної політики в Україні в межах режиму інфляційного таргетування.

Ключові слова: інфляція; інфляційні очікування; адаптивні очікування; раціональні очікування; гібридна неокейнсіанська крива Філліпса; HNKPC; інструментальні змінні; узагальнений метод моментів.

Вступ. Зниження рівня інфляції сприяє стійкому економічному розвитку, тому дослідження інструментів регулювання інфляції залишаються і залишатимуться актуальними. До того ж без розуміння чинників зростання цін складно будувати ефективну монетарну політику.

Вплив інфляції на економіку держави та окремих економічних агентів дуже значний. Високий рівень ін-