ASEAN Journal of Science and Engineering

Journal homepage: http://ejournal.upi.edu/index.php/AJSE/

Ergo design in Project Management Based on the General Theory of Transport Systems in the Conditions of the 10th Technological Order

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ABSTRACT

The purpose of this study is to forecast the development of a project approach to the modernization of transport systems during the 10th technological order; descriptions of methodological provisions of the general theory of transport systems (transportology, transport business theory). Studies of factors of growth of economic efficiency of project management in the field of transport formed by transportology. Description of the algorithm for the implementation of ergo design policy in project management, formation of a factor model of increasing the economic efficiency of scientific support for project management in the modernization of transport systems. The methods of the article are ergo design, methodology of science, theory of technological orders, modeling, project approach, and analysis in project management. the scientific novelty of the article is connected with the formation of ergo design and the scientific theory of transport systems (transportology, transport business theory) as a scientific basis for project management in the modernization of transport systems in the period of the 10th technological order.

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ARTICLE INFO

Article History:
Submitted/Received 08 Jun 2022
First revised 10 Jul 2022
Accepted 20 Sep 2022
First available online 22 Sep 2022
Publication date 01 Dec 2023

Keyword:
Ergo design,
Technological order,
Transport.

1. INTRODUCTION

At the beginning of the 21st century, project management acts as the main direction for the development and modernization of transport systems. At the same time, project management practically uses the latest scientific achievements in the modernization of transport systems.

The relevance of this work is determined by the need to increase the economic efficiency of the practical use of scientific support for project management in the modernization of transport systems in the conditions of the formation of a new 10th technological order. Such an increase in the efficiency of the use of scientific knowledge can be ensured by the application of the methodology of ergonomic design.

Problem statement: improving the efficiency of project management is associated with solving the problem of increasing the economic efficiency of the practical use of scientific knowledge in the modernization of transport systems of various hierarchical levels (global, national, regional, municipal) during the 10th technological order.

The hypothesis of the article is the assumption that the development of ergo design and the general theory of transport systems will improve the efficiency of project management in the field of transport in the period of the 10th technological order.

The work aims to increase the economic efficiency of project management in the field of transport in the period of the 10th technological order. To achieve this goal, the following tasks are solved:

(i) Forecasting the development of ergo design within the framework of the project approach to the modernization of transport systems in the period of the 10th technological order;
(ii) Descriptions of methodological provisions of the general theory of transport systems (transport ology, transport business theory);
(iii) Research of factors of growth of economic efficiency of project management in the field of transport, formed by transport ology;
(iv) Description of the algorithm for the implementation of ergo design policy in project management;
(v) Formation of a factor model for increasing the economic efficiency of scientific support for project management of modernization of transport systems.

The object of the article is national transport systems in the conditions of the 10th technological order.

The subject of the article is project management based on ergo design and the scientific theory of transport systems (transport ology, transport business theory).

Analysis of research on the topic shows the following. At the beginning of the 21st century, there is an innovative development of transport systems (Tiverovsky, 2018). Innovations need to be managed (Khramtsova & Khramtsov, 2019). At the same time, it should be taken into account that in 2022 there is a change in the paradigm of economic development in the direction of clustering of the economy (Smorodinskaya, 2012; Sukmawati & Maryanti, 2022). This determines the need for restructuring and modernization of transport systems. High-speed transport systems can be considered one of the key areas of development of transport systems (Misharin, 2015). At the same time, high-speed transport itself is considered a key factor in the innovative development of the economy.

The increasing importance and complexity of post-industrial transport systems led to the realization of the need to develop the theoretical foundations of transport systems. There is an increased interest in the development of the scientific foundations of project management for the modernization of transport systems. This is because, in post-industrial conditions,

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

science and education provide about 80% of the growth of the economy. This stimulates the development and modernization of the scientific foundations of most post-industrial science. There is a development of branch science in the field of design of transport systems (Glushchenko & Glushchenko, 2019). The need for projects to modernize transport systems is associated with the development of a new 10th technological order (Glushchenko, 2021a). In the period of the new technological order, technological platforms, clusters, ecosystems, and nature-like technologies have been developed. When modernizing transport systems and organizations, the methodology of organizational design is used. Innovations influence the development of the global and/or national economy and its monetary system (Glushchenko, 2022a; Ragadhita & Nandiyanto, 2022). At the beginning of the 21st century, such international transport projects as the Great Silk Road, the Northern Sea Route, and other projects are being implemented (Glushchenko, 2021b). These projects are part of the development of a new 10th technological order in terms of the development of anthropogenic systems. This leads to increased interest in the problem of improving the efficiency of project management in the field of transport (Aryi *et al*., 2020). A large number of projects carried out by the organization leads to the transition of this organization to the project model of its functioning (Glushchenko, 2022b). Great importance in the conditions of the new 10th technological order will be attached to the synthesis of effective innovative ideas (Glushchenko, 2021c).

During the development of the 10th technological order, the importance of the methodology of ergonomic design increases. In general, this study shows that there are a large number of publications on the topic of scientific support for project management. At the same time, publications often have a single character. Such publications do not have their further theoretical development (this is evidenced by the isolated nature of the publications of one author or a team of authors). At the same time, there is no information about the practical implementation and practical effectiveness of scientific publications in the field of project management. This allows us to conclude that in 2022 there is still no unified methodological basis for systematization and increasing the economic efficiency of the practical application of scientific knowledge in the management of projects for the modernization of transport systems. In such a situation, new methodological developments are needed.

These developments should increase the economic efficiency of the scientific basis of project management in transport activities. At the same time, it should be taken into account that it is in the course of innovative projects that new scientific results are introduced. An important part of improving the efficiency of project management can be the further development of the theory of technological orders and the general theory of transport systems (transport ology, transport business). The study of literary sources carried out in this article allows us to conclude the relevance of this article.

2. METHODS

An important tool for improving the effectiveness of scientific support in project management can be the methodology of ergonomic design. Under the ergo design policy in project management in this article, we will understand a set of measures aimed at coordinating the elements of the project implementation process in the interests of ensuring a comprehensive perception of both the project itself and its results.

At the same time, the process of ergo design itself can be implemented at several levels: at the level of the project itself; at the level of the project management process; at the level

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2775-6793 e- ISSN 2775-6815

of a scientific platform that includes a set of knowledge necessary for the implementation of this project.

The industry scientific platform can become an objective basis for the implementation of the ergo design policy in the company's project activities.

The joint use of the theory of technological orders and the general theory of transport systems in the ergo design of project management will allow:

(i) Generate productive ideas for innovative projects in the field of modernization of transport systems;
(ii) To select the most productive innovative ideas;
(iii) Evaluate the possibility of implementing innovative projects;
(iv) Reduce the risks of implementing innovative projects in the transport industry and much more.

At the same time, the general theory of transport systems should become the methodological and/or structural basis of the scientific project management platform. This is because it is known from the philosophy and methodology of science that only general theory is the most developed and practically effective form of scientific knowledge. Therefore, to improve the efficiency of project management, the key methodological provisions of the scientific theory of transport systems (transport ology and transport business) were formulated. Within the framework of the scientific theory of transport systems, the following were described: methodological function, instrumental, cognitive, legislative, prognostic, optimization, preventive, knowledge socialization, psychological, system-forming, and risk reduction function.

3. RESULTS AND DISCUSSION

Forecasting suggests that the development of the 10th technological order will further strengthen the impact of science and innovation on social and economic life (Glushchenko, 2021a). Historical analysis shows the close connection of the process of changing technological patterns with the development of technologies in the field of transport. The first technological order lasted from 5500 BC to 2000 BC. This technological order is associated with the invention of the sail. As a result of this invention, sailing sea and river vessels appeared. This allowed the development of sea and river transport systems. The second technological way was connected with the invention of horse-drawn traction. This technological way of life lasted from 2000 BC to the 10th century AD. Horse-drawn traction made it possible to intensively develop local ground transport systems (Guerfi *et al.,* 2021).

The third technological order lasted from the 10th century until 1770. This technological order is based on the invention of windmills. It is not related to the development of transport. The 4th technological order covers the period 1770-1830. It is called "Textile machines" and is not associated with the development of new types of means of transport. The fifth technological order lasted from 1830 to 1880. This technological order is connected with the invention of the steam engine. In turn, the invention of the steam engine led to the emergence of new types of vehicles with this engine (steamship, steam locomotive). This ensured the emergence of regularly functioning international transport systems.

The sixth technological order continued in the period from 1880 to 1930. This technological order is connected with the invention of the internal combustion engine and the electric motor, based on these engines, such vehicles are created: diesel locomotives; airplanes; cars; trolleybuses, and electric cars. A new type of transport has appeared - air transport. The seventh technological order lasted from 1930 to 1970. During this period, the following were invented: a nuclear reactor, computers, automated control systems, and more. The nuclear

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

engine has led to the fact that the means of transport have become global (without a real limitation of the range of transportation). The eighth technological order (1970-2010). It is connected with the development of microelectronics. This made it possible to increase the level of automation of vehicle management.

It is predicted that the 10th technological order in the field of transport will be characterized by the following: the development of high-speed ground transport; the invention of unmanned vehicles; the development of digitalization in transport systems; the use of neurotechnology in the field of transport systems; the use of information technologies; the use of resource-saving technologies; the use of environmentally friendly technologies and other (Glushchenko, 2021a).

The development of transport systems as a function of the process of changing technological patterns is presented in **Table 1.** To improve the efficiency of project management, it is proposed to use scientific support in the form of a scientific platform. Within such a scientific platform, the knowledge focused on this platform can be structured based on various factors of the project management process. These may be the following factors: subject areas (marketing, management, finance, etc.); elements of the transport system (means of transport; transport infrastructure; traffic management system, etc.); types of transport (aviation, cars, ships, etc.); key technologies of the 10th technological order and more.

When creating such a scientific platform, it is recommended to take into account the experience of creating technology platforms in EU countries, but it should be borne in mind that technology platforms in the EU are tools for information contacts.

Under the scientific platform of project management in the field of transport, we will mean the systematic unification of scientific knowledge from various branches of science necessary to solve the problems of safe and economical creation of new objects of the transport system in the course of an innovative project. In the scientific platform for project management aimed at the modernization of transport systems, segments related to the development of key technologies of the 10th technological order can be identified. The introduction of new technologies into vehicles, in turn, will lead to an increase in the economic efficiency of science and innovation. This will increase the economic efficiency of innovative projects in the field of transport in the period of the 10th technological order.

In the process of developing transport science in the form of a scientific platform in the conditions of the 10th technological order, it is important to take into account that the functions of the general theory of transport (transport ology, theory of transport business) can act as: firstly, factors of structuring knowledge on this platform; secondly, as directions of development of this scientific platform.

For example, within the framework of the methodological function of transport ology, further developments will be carried out: the conceptual apparatus of project management; the methodological foundations of the management of such projects; the theoretical foundations of scientific research of transport systems, and more. The cognitive function of transport ology is aimed at registration, storage, research, project management processes, facts of reality, and results of scientific research of transport systems. The instrumental (regulatory) function of transport ology will be aimed at creating methods and tools for project management, as well as management of scientific research in the modernization of transport systems.

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

Table 1. Development of the transport sector with the change of technological patterns

No	Properties of technological orders (structures) /number orders, Rs, period; names technological order	Transport system, new types of transport	New types of products; Types of production enterprises
1	The first technological order; the period from 5500 BC to 2000 BC; sails for river and sea vessels	Local transport systems; sailing sea and river vessels, rowing vessels	Products of agriculture and animal husbandry; organization of subsistence farming within the genus
2	The second technological order, period 2000 BC -400 BC; horse traction;	The emergence of horse-drawn transport systems	Natural raw materials, agricultural products, transport services; Family, community
3	The third technological order; period 400 BC 9th century AD; the invention of the saddle, the appearance of pack transport	Local transport systems; extension of land transport routes to hard-to-reach regions	Natural raw materials, agricultural products, transport services; Family, community
4	The fourth technological order; Period 9th century-1770; Windmill, a water mill;	Intercontinental transport systems; sailing sea and river vessels, rowing vessels	Flour, sunflower oil; products of mechanical processing of agricultural products; Family, clan, craftsman, miller
5	The fifth technological order, period 1770-1830; Textile machines;	Intercontinental transport systems; sailing sea and river vessels, rowing vessels	Machine-made fabrics, manufactory products; Textile manufactories, Enterprises;
6	The sixth technological order; Period 1830-1880; steam engine;	Intercontinental transport systems; the steam-powered sea and river vessels	Steam engines; mechanisms; locomotives, rails; sleepers; International monopolies
7	The seventh technological order; Period 1880-1930; electric motor and internal combustion engine;	Global transport systems using different modes of transport; the sea and river vessels with internal combustion engines; cars; airplanes	Cars, diesel locomotives, airplanes, washing machines, refrigerators; radio, telegraph; Multinational corporations,
8	The eighth technological order; Period 1930-1970; nuclear reactor, electronic computers;	All-weather transport systems using a nuclear icebreaker fleet;	Electronic computers, televisions; automation tools; flexible automated production complexes; Multinational corporations,
9	The ninth technological order; Period 1970-2010; microelectronics and microprocessors;	All-weather transport systems using a nuclear icebreaker fleet; automation of transport systems and navigation systems	Personal computers; ATMs; plastic bank cards; mobile phones; Multinational corporations, virtual corporations; strategic alliances of corporations
10	The tenth technological order; Period 2010-2040; nanotechnologies and neurotechnology;	Intelligent transport systems; unmanned vehicles; environmentally friendly all-weather transport	3-D printing products, information products, the transformation of human thinking (clip thinking); global information systems; clusters; technology platforms

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

The legislative function of transport ology will cover the process of creating legislative norms in the field of project management and research in the field of transport systems. The optimization function of transport ology is responsible for maximizing the economic efficiency of the processes of obtaining and practical use of knowledge during the implementation of projects in the field of modernization of transport systems. The predictive function of transport ology will ensure the formation of probabilistic judgments about the effectiveness of obtaining and/or using knowledge in projects for the modernization of transport systems. The preventive function of transport ology is aimed at ensuring the safety of project management processes.

To ensure the safety of projects, the acquisition and use of knowledge about transport systems will be applied. The psychological function of transport ology forms the feeling and perception of the importance of scientific support for project management; the development of innovative thinking in project management. The function of knowledge socialization in transport ology covers the process of spreading knowledge about the important role of project management in modern and promising transport systems. The system-forming function of transport ology is the scientific support of the processes of system unification (aggregation) of individual parts into a single whole - the project of modernization of the transport system.

Using the functions of transport ology as directions for improving the efficiency of project management to increase the degree of use of scientific knowledge in the project management system. Consequently, the functions of transport ology can become a system-forming factor in the formation of a scientific platform for the management of transport system modernization projects. This approach will make it possible to better coordinate project management and scientific research, to avoid "gaps" in the scientific support of project management.

The role of transport ology in project management processes can be considered: increasing the level of project coordination; optimization of scientific and innovative projects in transport systems; increasing the economic efficiency of applying scientific knowledge in projects in practice; reducing the share of unproductive projects; reducing the share of scientific publications that have no practical significance in projects.

The following statements can be recognized by the laws of transport ology concerning project management in the field of transport: the importance of project management efficiency in the economy will increase; the role of science and education in ensuring the effectiveness of projects will increase; the role of management in increasing the economic efficiency of science in the field of transport will increase; the development of the theory of technological orders and transport ology in the form of a scientific platform will increase the economic efficiency of transport since the effectiveness of project management is based on scientific knowledge.

The idea of integrating the theory of technological structures and transport ology as two areas of a single methodological basis for project management can become the basis for creating a scientific project management platform. Such integration of the two theories can be based on the methodology of ergo design.

Concerning the scientific platform of information support for project management, it is possible to use ergonomic design methods. These methods can provide a perception of the project management process based on scientific knowledge in general; increase the level of harmonization of project management processes.

The architecture of the scientific project management platform in the field of transport can be understood as: style, art, emotional perception of design processes; creation of scientific

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

and technical support for project management systems; organization and design of user interaction processes and project management systems; optimization of the processes of using scientific knowledge in the project management process.

The main tasks of the architecture of the scientific project management platform can be recognized as the formation of a unified style of obtaining, systematization, evaluation and practical application of knowledge. Such a unified style of these processes (obtaining and using knowledge in projects) was created in the interests of improving the efficiency of project management processes and scientific research within such projects.

The sphere of development of scientific support for project management in transport is characterized by an architecture that can be called a "technological pyramid of projects": the 1st level of this pyramid is responsible for the synthesis of projects aimed at creating new technological principles of the transport system; the 2nd level of this pyramid is formed by projects aimed at designing vehicles; the 3rd level of this pyramid the pyramid consists of projects for the production of vehicles; the 4th level of this pyramid consists of projects for the service of transport customers; At the 5th level of this pyramid there are projects related to technical and social services in transport.

The organizational design of the scientific project management platform will include the method and specifics of the organization of the structure of the project management process; the nature of the interaction of various scientific approaches, and scientific disciplines in the project management process.

Ergo design factors to ensure the effectiveness of building a system of scientific support for the project management process (in the form of the considered scientific platform) include the following:

(i) Classification and storage of scientific knowledge about the project within the framework of the functional architecture and/or the architecture of the "technological pyramid" will make it possible to predict the development of scientific support for project management, timely identify "bottlenecks" in the scientific support of project management, which will have a positive impact on the economic efficiency of such project management;

(ii) The ergo design of the process of practical use of knowledge within the framework of an industry scientific platform should be more effective by increasing the level of complexity of such practical application of knowledge based on their more accurate and complete application in practice;

(iii) Ergo design can help to increase the economic efficiency of using the knowledge included in the scientific platform by optimizing the architecture and organizational design of the project;

(iv) The formation of a complex of scientific knowledge about the project within the framework of the industry scientific platform will increase the level of assimilation of knowledge and practical skills (competencies) of students in the process of their studies at universities, which in turn will increase the economic efficiency of project management in the transport industry.

In the discussion, we explain the thesis about the effectiveness of ergo design in project management. Such an ergo design should be aimed at improving the efficiency of the practical integrated use of knowledge located in the industry scientific platform. We will make such an explanation using the example of an innovative project to create a technical means of transport (aircraft, car, river or sea vessel, and others). The analysis of the innovation project shows that the effectiveness of the innovation project is influenced by scientific support for solving problems on many external and internal factors of this project.

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

To create a competitive model of a vehicle on the global market, it is necessary to solve the following external problems of this project on a scientific basis: optimization of project financing sources; formation of an association (pool) of venture investors and/or business angels (which refers to the specialty finance and credit); to analyze and evaluate the capacity of the target market segment for this vehicle (what belongs to the specialty marketing); to assess the possibility of using advanced foreign technologies in the project (relates to the sphere of international scientific and technical cooperation); to develop a forecast and assess the likelihood of the appearance of analogues (substitutes) of this vehicle (relates to the theory of technological orders and global competition); to form an atmosphere of support (mentoring) of this project by public authorities (included in the spheres of PR and public-private partnership); formation of a coalition of executors and co-executors of the project (project management area); to develop and implement a marketing policy to promote the vehicle to consumers (refers to the marketing of the project); to form a technological process of customer service (transport service); to analyze and synthesize the brand of the vehicle, etc. The application of the ergo design methodology in project management will allow solving these external scientific and practical problems of the project in their systemic unity.

It is important to note that within the framework of the ergo design of project management, the following should be solved in a systematic unity: external problems of the project; internal problems of the project; issues of harmonious solution of external and internal problems of this innovative project. A typical list of internal scientific and practical problems of a typical innovation project is presented in the work. This list should be adapted to the specifics of a specific vehicle development project. At the same time, it should be borne in mind that these external and/or internal scientific and practical management decisions concerning the vehicle development project are interrelated.

In addition, project management decisions made at the junctions of various disciplines are based not only on explicit but also on implicit knowledge. Implicit knowledge is the knowledge that cannot be expressed and transmitted by verbal methods (Sigov & Tsvetkov, 2015). This kind of implicit knowledge arises in project management: at the junctions of scientific areas (technology, pricing, management, marketing, etc.); at the intersection of vehicle properties (for example, load capacity and speed); in the process of combining (aggregating) elements into a single whole- a system (for example, choosing an engine power option with a known vehicle platform) and other cases. At the same time, implicit knowledge can act as the basis for the formation of a synergetic effect from the vehicle project based on the system integration (aggregation) of elements and components in the new vehicle being created.

The development of an industry scientific platform based on transportology can be even more cost-effective if it is combined with: the methodology of ergonomic design in project management; with a more active application of the product (project) approach in scientific and/or innovative activities; with the optimal organization of project groups (teams); with the creation of matrix organizational structures in organizations, carrying out development and other types of innovative projects.

The active application of the method of modeling the processes of obtaining and using scientific knowledge in ergo design can contribute to improving the efficiency of project management. Even in this case, the scientific theory of transport systems (transportology, transport business) can be a tool for increasing the effect of ergo design in the field of practical use of scientific results.

The positive effects of ergo design can be observed with the systematic unification of knowledge belonging to various areas of innovation, technology, economics, and management, which can create a synergetic effect; reducing the risks of lack of necessary

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

scientific knowledge; customization concerning the problems of managing research projects; increasing the likelihood of timely finding relevant scientific knowledge; highlighting priority areas of scientific research; increasing the level of customer orientation in the scientific and educational work of industry transport universities and more (Nugroho, 2022; Shaturaev, 2023).

The stages of implementing the ergo design policy in project management can be called the following actions:

(i) Synthesize industry scientific theory;
(ii) Based on industry scientific theory to form a scientific platform as a basis for project management in the industry;
(iii) To analyze the sufficiency of the volume of scientific knowledge within different segments of the scientific platform (various functions of this branch theory);
(iv) Identify "white spots" (insufficient level of knowledge) on certain types of knowledge in demand in project management;
(v) To fill in the "white spots" in the scientific support of project management;
(vi) Harmonization of knowledge volumes is carried out within the framework of various: stages of project management; various types of activities in project management; knowledge related to various functions in industry theory;
(vii) Organize the effective use of industry knowledge in project management;
(viii) To assess the level of harmony of perception of processes: project management; the process of obtaining new knowledge; the process of using existing knowledge and more.

Ergo design can have a positive effect on project management processes in such cases, specifically, in the processes of obtaining missing knowledge, when using scientific knowledge in the implementation of innovative projects, and when solving the problem of improving the quality of higher transport education. Factors for increasing the economic efficiency of projects based on the general theory of activity in the industry can be:

(i) Improving the efficiency of the processes of obtaining new knowledge during the implementation of the project;
(ii) Increase in the economic efficiency of the use of industry scientific knowledge during the implementation of the project;
(iii) Increasing the quality of professional education of project participants and more. Based on this, the following coefficients can be proposed:

Next, we can consider the innovative money multiplier (*Mi*), which reflects the process of multiplying the amount of money when carrying out activities in the industry in which a specific project activity is carried out (Glushchenko, 2022a). In the first approximation, the innovative monetary multiplier can be calculated as the ratio of the added value of the project to the cost of the raw materials and materials that were used for the implementation of the project. The concept of an integrated innovative monetary multiplier (*Mii*) can be introduced, which can be found by equation (1):

$$Mii = Mi \cdot Kgk \cdot Kuk \cdot Kie \quad (1)$$

where *Kgk* is the coefficient (greater than 1) reflecting the increase in the efficiency of obtaining scientific knowledge in the project during the creation and ergo design of the scientific platform. *Kuk* is the coefficient (greater than 1) characterizing the increase in the economic efficiency of the use of scientific knowledge in the project as a result of the formation and ergo design of the scientific platform. *Kie* is the coefficient (greater than 1) associated with the growth of improving the quality of higher education based on the ergo

DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938

design of scientific knowledge in projects after the creation of an industry scientific platform. Each of these coefficients can be determined by an expert method.

An increase in the net reduced effect when implementing a project using ergo design in project management (*NPV*) can be described by equation (2):

$$NPV = NPV\ e - NPV\ we \quad (2)$$

where *NPV e* is the net reduced effect of the project when managing the project using the ergo design methodology. *NPV we* are the net reduced effect of the project when managing the project without using the ergo design methodology.

An increase in the integral innovative monetary multiplier makes the monetary system of the state stable and makes the national currency solid (constantly growing in price). This contributes to increasing the resilience of the national economy to currency risks.

4. CONCLUSION

The paper develops the basics of ergo design in project management based on the scientific theory of transport systems (transport ology, transport business). Methodological provisions for the creation of a scientific platform are being developed in the interest of increasing the economic efficiency of project management. Improving the efficiency of project management is provided through the use of scientific knowledge. The article proposes a three-factor model for assessing the level of efficiency of obtaining and using scientific knowledge as part of an industry scientific platform. The improvement of the quality of higher education as a result of the formation of a scientific platform is justified. The algorithm for practical implementation of ergo design policy in project management is proposed.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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DOI: https://doi.org/10.17509/ajse.v3i3.50799
p- ISSN 2776-6098 e- ISSN 2776-5938