DOI: https://doi.org/10.32782/2524-0072/2024-68-60

UDC 330.341

THE BOX MODEL AND PRODUCT READINESS LEVEL: DETERMINING THE VIABILITY OF IDEAS

СКРИНЬКОВА МОДЕЛЬ ТА РІВЕНЬ ГОТОВНОСТІ ПРОДУКТУ: ВИЗНАЧЕННЯ ЖИТТЄЗДАТНОСТІ ІДЕЙ

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This work proposes a combined approach to assessing the effectiveness of technology (innovation) transfer, which uses the method of "box" modeling of systems, as well as an assessment of the level of readiness of the product for introduction to the market. This approach's peculiarity is considering the product transfer process from an idea to a viable and competitive development at the micro and macro levels. At the micro level, a set of tools is applied to assess the level of product readiness for implementation (TRL, IRL, IPRL) without describing the technology transfer environment. At the macro level, the box approach is applied, allowing us to consider technology transfer as a system with input and output parameters, system parameters, control parameters, and disturbing parameters. The combined approach for simultaneous assessment of the state of readiness of the product for implementation and transfer efficiency according to the home model of chests and TRL-IRL-IPRL scales allows the implementation of two parallel processes. On the one hand, an assessment of the product life cycle as an element of the ecosystem of innovation transfer is carried out, taking into account input (what does the market need?) and output (what result will be obtained?) parameters. On the other hand, the evolution (life cycle) of the product's readiness for market introduction is monitored as an element of innovation transfer management. Implementing the main provisions of this approach will avoid errors in managerial (technology transfer) and technological (product life cycle) decisions at each level of product readiness for implementation due to the possibility of returning to the previous stage rather than at the end of the life cycle.
Keywords: technology transfer, box approach, readiness level, TRL, IRL, IPRL.

У роботі запропоновано комбінований підхід до оцінки ефективності трансферу технологій (інновацій), який використовує метод «скринькового» моделювання систем, а також оцінку рівня готовності продукту до виведення на ринок. Особливістю цього підходу є розгляд процесу трансферу продукту від ідеї до життєздатної та конкурентоспроможної розробки на мікро- та макрорівнях. На мікрорівні застосовується набір інструментів для оцінки рівня готовності продукту до впровадження (TRL, IRL, IPRL) без опису середовища трансферу технологій. На макрорівні застосовано скриньковий підхід, що дозволяє розглядати трансфер технологій як систему з вхідними та вихідними параметрами, параметрами системи, параметрами управління та параметрами, що збурюють. Комбінований підхід для одночасної оцінки стану готовності продукту до впровадження та ефективності трансферу за даними вітчизняної моделі скрині та шкал TRL-IRL-IPRL дозволяє реалізувати два паралельні процеси. З одного боку, проводиться оцінка життєвого циклу продукту як елемента екосистеми трансферу інновацій з урахуванням вхідних (що потрібно ринку?) та вихідних (який результат буде отримано?) параметрів. З іншого боку, здійснюється моніторинг еволюції (життєвого циклу) готовності продукту до виведення на ринок як елемент управління трансфером інновацій. Реалізація основних положень цього підходу дозволить уникнути помилок в управлінських (трансфер технологій) та технологічних (життєвий цикл продукту) рішеннях на кожному рівні готовності продукту до впровадження завдяки можливості повернення на попередній етап, а не в кінці життєвого циклу.

Ключові слова: передача технологій, скриньковий підхід, рівень готовності, TRL, IRL, IPRL.

Introduction. The innovation transfer process can reach the "valley of death," where ideas do not have a chance to turn into a product that will succeed in the market. In addition, there are different opinions of technology transfer experts regarding the essence of innovation. On the one hand, innovation is interpreted as a promising idea that can turn into a product and has predicted advantages compared to analogs. On the other hand, some experts believe that innovation is a ready-made product already on the market, has been tested, and has shown advantages compared to analogs. The first option can be convenient for universities – centers of innovative scientific ideas, and the second – for universities with an entrepreneurial component, which can ensure the entire life cycle of product creation and its entry into the market.

In most cases, universities are between the first and second option; they have the desire to implement the transfer of an idea into a product, but at certain stages, they face difficulties in overcoming the "valley of death." This paper proposes the combined use of the "box" approach and scales of product readiness levels for implementation as a tool for reducing the risks of entering the "valley of death" at the stage of the "materialization" of an idea and its transformation into a product prototype.

Analysis of recent research and publications. Consideration of the "black" box, "gray" box, and "white" box systems in application to various systems in the economy, cybernetics, and information technologies was thoroughly conducted in works [1–6]. In education, the indicated systems are used in the vast majority not as a tool for establishing the regularities of the course of this or that educational process but as applied directly to work in the classroom. This is confirmed in works [7; 8].

It should be noted that, for example, in work [9], an attempt was made to analyze the cause-and-effect relationship "education – economic growth" as a "black box." The author states that while economists considered education an expense the state bears, this only applied to philosophers and educators. As a consumer product, education depends on personal preferences, family income, and the cost of education. However, later, the theory of human capital revolutionized: turning into an investment, education became a problem for the state, and it aroused the real interest of a large and diverse group of experts, decision-makers, politicians, sociologists, economists, statisticians, functionaries, etc. In the first phase, educational economists focused their research mainly on descriptive international comparisons or educational planning based on labor force estimates. Subsequently, the theory of human capital prompted the development of other econometric approaches, for example, based on indicators of the cost of education and the amount of profit.

The author's approach to using the chest method for modeling processes of quality management of educational and scientific activity was presented in the work [10], where analogies between technical systems and the description of non-technical processes were given. This work gave impetus to a deep understanding of the possibility of applying the chest approach to modeling the innovation transfer process.

On the other hand, the author's approach SPACE-RL [11] laid the foundations for determining the level of development readiness for implementation based on a combination with other methods (TRL [12], IRL [13] and IPRL [14]), as well as the use of well-known software packages for assessment of the level of development readiness (for example, [15]).

Based on the above, the authors formed the idea of creating a new approach to the description of the innovation transfer process, which would simultaneously consider the life cycle of the product (which is the object of transfer) and the innovation transfer process as a system with input and output parameters, system parameters, management parameters, and disturbing parameters. Implementing this idea will make it possible to comprehensively consider the transfer of innovations in the context of the main stages of the product's "life" and the transfer environment.

The aim of the article. The purpose of this article is to describe the methodology for assessing the potential of scientific development at various stages of its life cycle by evaluating the following factors:

– input data (background) for the creation of an innovation and its entry into the market;

– output data – competitive characteristics of the product;

– parameters of two systems: the product at different stages of its life cycle (the system as an object) and the innovation transfer process (the system as a process);

– parameters for managing the level of product readiness for implementation and the innovation transfer process;

– disruptive parameters of innovation transfer;

– the life cycle of a product-innovation, considering the technological, intellectual, and innovative level of readiness.

Results and discussion.

Figure 1 illustrates a conceptual model of technology transfer. Here's a detailed breakdown of its components.

Inputs represent the resources, data, or initial conditions required for the technology transfer process.

Technology transfer parameters indicate the primary set of conditions and variables driving the process. These parameters likely include the essential factors that enable technology transfer from development to implementation.

Product readiness parameters represent a subset of parameters specific to assessing or ensuring the product's readiness for use. These might include quality standards, testing benchmarks, or validation metrics necessary for determining that the product is ready for market or deployment.

Environmental, monitoring, and control parameters are shown as influencing factors that impact the technology transfer process. These parameters may include external conditions, environmental controls, or monitoring metrics that must be maintained or adjusted for successful transfer. They could represent regulatory conditions, operational monitoring, and quality assurance controls.

Disturbing parameters indicate disruptive elements or potential challenges affecting the technology transfer process. These may include unforeseen technical issues, external market factors, or other variables that pose risks or introduce complications in the transfer process.

Outputs represent the result of the process after the inputs have been processed through the technology transfer parameters, readiness checks, and various external influences. The outputs are the technology transfer's outcomes, products, or results.

Figure 2 presents a decision-making and assessment model for evaluating a product's readiness in the context of technology transfer. It integrates various parameters and stages to determine if a product meets customer

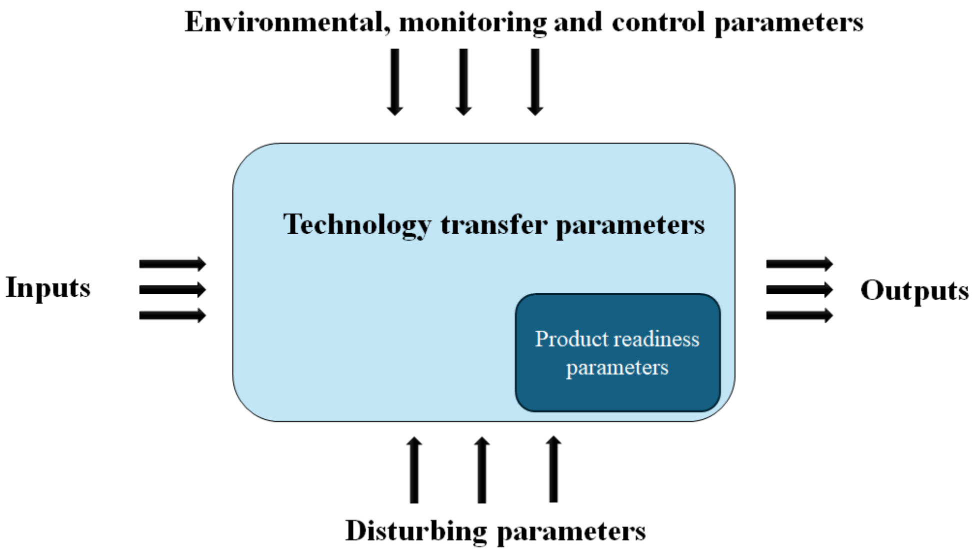

Figure 1. Box approach in the modeling of technology transfer

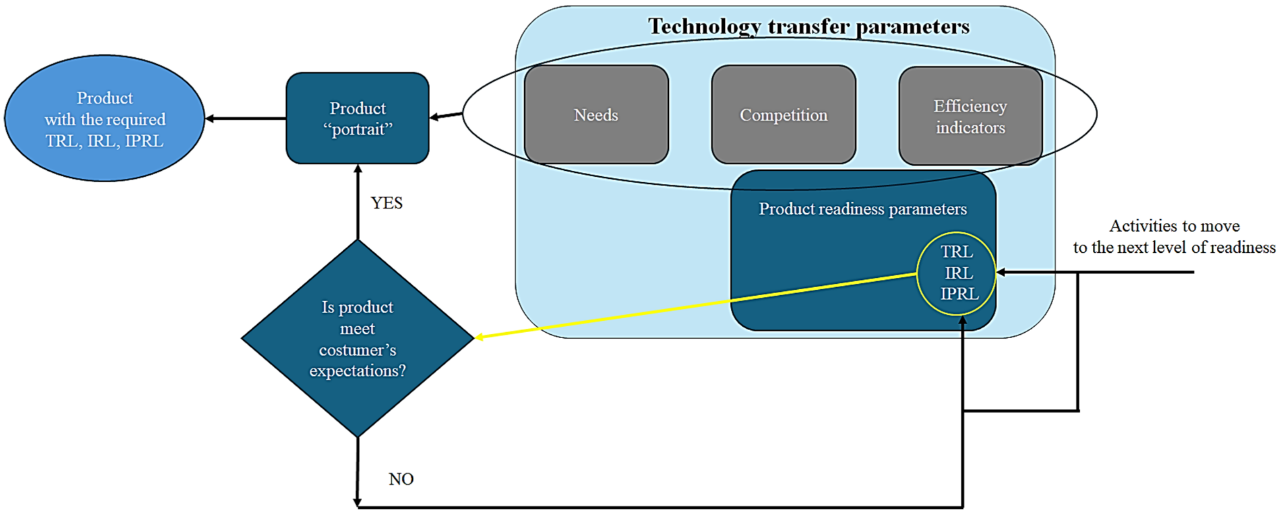

Figure 2. Technology transfer and product readiness: mutual influence

expectations and is ready for the next level of deployment or requires additional work.

1. Initial Product Readiness.

The process begins with a product with some TRL, IRL, and IPRL.

TRL: Technology Readiness Level, a measure of the maturity of technology.

IRL: Integration Readiness Level measures how well the product integrates with other systems.

IPRL: Intellectual Property Readiness Level, which likely assesses the readiness of information and IP aspects.

2. Technology transfer parameters.

Needs: refers to the specific requirements or functional demands of the product.

Competition: involves benchmarking against competing products or technologies in the market.

Efficiency Indicators: metrics that assess the efficiency and performance of the product.

Together, these parameters shape the product readiness parameters, guiding the product's development and adjustment to meet readiness standards.

3. Product "portrait".

The product enters the assessment process, represented by a box labeled Product "portrait." This box represents an evaluation or product profile based on certain attributes.

4. Customer expectation check.

Yes: if the product meets customer expectations, it progresses forward (suggesting readiness for further action or deployment).

No: it loops back if it does not meet expectations, indicating that further adjustments or improvements are needed.

5. Activities for improvement.

Suppose the product meets the initial criteria but requires further refinement. In that case, specific activities or tasks will be undertaken to raise its readiness levels (TRL, IRL, or IPRL) to the next stage.

If the product fails to meet customer expectations (as indicated by a "No" at the decision node), the model shows a feedback loop directing the process back to earlier stages. This loop suggests an iterative process where the product is repeatedly assessed and refined until it meets the required standards.

Conclusions and prospects for further research. The combined approach for simultaneous assessment of the state of readiness of the product for implementation and transfer efficiency according to the box model and TRL-IRL-IPRL scales allows the implementation of two parallel processes. On the one hand, an assessment of the product life cycle as an element of the ecosystem of innovation transfer is carried out, taking into account input (what does the market need?) and output (what result will be obtained?) parameters. On the other hand, the evolution (life cycle) of the product's readiness for market introduction is monitored as an element of innovation transfer management.

Among the tasks of further research are the implementation of the proposed algorithm in the form of software, as well as the process of software testing according to the "unit testing – quality control – quality assurance" algorithm and the application of an agile approach in contrast to the "waterfall" concept, which does not allow making changes to various stages of the innovation life cycle, and forms feedback only after passing all stages of the innovation transfer process (successful or unsuccessful in the end, which is problematic to predict).

Acknowledgment. The research is supported by the budget of the Ministry of Education and Science of Ukraine (research topic 0122U000772 "Business-Education-Science" Coopetition: Institutional and Economic Models of Innovation Transfer for National Security and Sustainable Development) and by a European Union grant "Immersive Marketing in Education: Model Testing and Consumers' Behavior" (No. 09I03-03-V04-00522/2024/VA)

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