

## A Model for Protecting Competitive Advantages in the System for Managing the Innovative Security of an Engineering Enterprise under the Influence of Digitalization of the Economy



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### ABSTRACT

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The main purpose is to determine ways to ensure the protection of the competitive advantages of the engineering enterprises innovation security management system. The object of the research is competitive advantages and systems for ensuring their protection for engineering enterprises. The research methodology involves the use of modern graphical modeling techniques to increase the effectiveness of the innovative safety management system in the context of ensuring the protection of competitive advantages. The relevance of the research is added by the fact that at the moment the issue of competitive advantages in ensuring innovative safety of the engineering enterprise is highlighted quite sporadically, mainly in terms of a certain type of competitive advantages. The obtained research results are presented in graphic form and can be used by managers of engineering enterprises. Further research should be devoted not only to ensuring the protection of competitive advantages, but also to the key tools for their development for the engineering sector of the economy.

## 1. INTRODUCTION

An engineering enterprise must be a generator of innovations that attract customers (which, of course, not everyone succeeds in), and at the same time be receptive to any innovations, regardless of origin, if they allow now or in the future to gain certain competitive advantages or at least achieve equal with competitors provisions on the quality characteristics of the product and its usefulness to buyers, while achieving certain price advantages.

In fact, it is not goods that compete in the global engineering market, but the system of organizing production and marketing. All technical, technological, organizational and other advantages are ultimately reflected in the attractiveness of the product for the buyer in all its characteristics.

Competitive advantages are formed under the influence of many factors - economic, industrial, technical, technological, organizational, informational, etc. Therefore, both in achieving competitive advantages and in their preservation, all services and divisions of the engineering enterprise take part.

For most engineering enterprises, the outdated concept of creating and launching a new product on the market, based on the costly pricing method, still prevails: the cost of production and sale of a new product is determined, the necessary (at the discretion of the manufacturer) rate of return is attached to it, and the selling price is formed. Such a concept could be relied upon in the past, when the market was basically a seller's market, it dictated the rules of the game. The current market is

usually a buyer's market, it is impossible to dictate your terms to it. In such conditions, competition is growing and the question of the proper management of innovative security.

Sustainable economic growth is impossible without the development and support of a full-fledged competitive environment within which business entities operate. The degree of development of competition depends on the possibility of improving the economy, the economic growth of both the country as a whole and individual economic entities, the degree of their participation in the international division of labor. Consequently, competition has been a constant object of study for scientists from different countries and systems for more than two hundred years. However, there are a number of fundamental problems, such as determining the essence of competition, the features of its manifestation in individual industries, the evolution of competition depending on the level of development of the country's economy and society, which require constant refinement and the search for new solutions adapted to the realities of the development of individual economic systems. In the whole context, modeling the correct protection of competitive advantages for engineering enterprises is not only relevant.

The main purpose is to determine ways to ensure the protection of the competitive advantages of the engineering enterprises innovation security management system. To do this, it is necessary to model the key stages of this process under the influence of the digitalization of the world economy.

## 2. LITERATURE REVIEW

Analyzing the scientific and practical literature, one should pay attention to several fundamental theses. A significant number of scientists [1-3] argue that competitive advantage is always relative, compared to an engineering company that occupies the best position in the market for a product or service. Competitive advantages can take different forms depending on the specifics of the industry, product and market. When determining the protection of competitive advantages, it is important to focus on the needs of consumers and make sure that these advantages are perceived by them as such. Otherwise, it may be, for example, that the company considers itself well-known in the local market and does not spend money on advertising, and consumers do not have information about this company. The functioning of an organization in a market economy implies a state of continuous competition for a place in the market, which implies an endless search for the most effective ways to use resource potential, innovation, investment, reduce production costs and improve pricing policy. In turn, it is the presence of competitive advantages that forms the basis for the effective development of the organization and the achievement of its economic security.

By implementing the development strategy, the engineering enterprise changes the value of indicators of financial and economic, information, personnel, production and technological and economic security levels. Increasing the level of indicators of economic security increases the risk, so the balance between risk and profitability is the primary task of the economic security structure. According to scientists, a high level of enterprise security guarantees the sustainability of development and the achievement of competitiveness of products and organizations in the long term. The values of indicators of efficiency, financial stability, investment attractiveness, competitiveness should not be lower than the values at which the strategic goal is achieved [4-6].

In the scientific literature [7-12], it is noted that the study of the competitive advantages of engineering enterprise allows you to identify strengths and weaknesses, outline ways and develop measures to increase competitiveness in order to give your success a long-term character and provide the necessary share in the relevant market. Effective business development allows a business entity to be competitive, which in turn ensures the achievement of security based on the reduction of external and internal threats. A timely and high-quality assessment of the level of economic security of an organization can be called the main factor in sustainable development.

Considering the scientific contribution of the majority of scientists and practitioners to the development of problem solving, it should be noted that a number of aspects of ensuring the protection of competitive advantages of enterprise engineering in the context of digitalization remain relevant, and using new methodological approaches will be new.

## 3. METHODOLOGY

The key research method is the method of graphical modeling. The innovation security management system and ensuring the protection of competitive advantages is a complex process that requires information and accuracy. This can be achieved through modern modeling techniques.

The system modeling methodology is necessary for the

analysis and further search for ways to improve and develop aspects of protecting competitive advantages in the innovation security management system of a engineering enterprise under the influence of the digitalization of the economy. The main requirement for the modeling methodology in ensuring the protection of competitive advantages in the innovation security management system is the presence of a holistic approach to the activity of the engineering enterprise, in which the types of its activities and, accordingly, the types of models are linked and coordinated. One such way could be IDEF.

Speaking about the advantages of the IDEF methodology as a whole, it should be noted that the breadth and depth of the examination of processes in the system are determined by the developer himself. This allows not to overload the created model, for example, the model of protecting competitive advantages in the innovation security management system of a engineering enterprise under the influence of the digitalization of the economy, with unnecessary data. Конкретні переваги проявляються на етапі побудови та редагуванні моделей. When using IDEF, it is very convenient to change the data and adapt it elastically to the environment. The stages are very simply defined, first the main goal and then how to achieve it. All this is easy to depict graphically.

IDEF modeling methodology implies a certain sequence of actions: creation of a functional (conceptual) model; determination of the data necessary for the implementation of the model; mathematical modeling; evaluation of results; model reorganization; iteration until the model is "framed". In accordance with this, a series of descriptions has been created, and now 15 notations (standards) are included in the IDEF family. One of the 15 categories just includes the selected IDEF0 method. That is, we thus narrowed down to one clear method.

In this regard, to study the processes of ensuring the protection of competitive advantages in the management system of innovative security of a engineering enterprise under the influence of the digitalization of the economy, the IDEF0 functional modeling methodology is of considerable interest, which allows reflecting and analyzing activity models of a wide range of complex systems in various aspects. Modeling with IDEF0 is the first step in learning any system. The IDEF0 functional modeling methodology uses a graphical language for describing the functioning of complex systems SADT (Structured Analysis and Design Technique) - a technology for structural analysis and technical design.

The main advantage of the IDEF0 methodology is its effectiveness in detailing the existing system of work in functional modeling. The purpose of IDEF0 is the structural analysis of relationships in a complex object. Works are described by inputs, outputs, control actions and mechanisms. The description of work can be detailed to the level at which the generated model allows making decisions on improving the protection of competitive advantages in the innovation security management system of a engineering enterprise under the influence of the digitalization of the economy. In IDEF0, a model is built as a collection of interacting activities and functions. Functional orientation in this case is fundamental, which allows you to accurately model the logic and interaction of processes.

Solutions implemented according to the IDEF0 methodology improve data exchange in engineering enterprise, providing collaboration between administrators and database developers, allowing reuse of the generated models, as well as

visualization of complex data arrays in an easy-to-understand and maintain format. The IDEF0 methodology has found widespread use due to its simple and understandable graphical notation. At the same time, the main place in the visualization of the process is given to diagrams in which geometric shapes (usually rectangles) display the functional blocks of the system, and the arrows show the links between the functions of the controlled system and the external environment.

In our case, we have a situation where a clear task needs to be set for the model in order to launch a further algorithm of actions that will be presented later in the text in the results. Such a task will be - Ensure the protection of competitive advantages in the management system of innovative security of a engineering enterprise under the influence of the digitalization of the economy. We conditionally denote the problem as A(0). It is achieved by the successful execution of a number of sub-processes and the fulfillment of the following condition (1):

$$A(0)=A(1)+A(2)+A(3)...+A(n) \quad (1)$$

Relationship between each sub-process occurs at the stage of obtaining information about the progress of implementation and working out the results that it can bring to the overall achievement of the goal. If there is a possible conflict, the processes are edited.

Moreover, each process A(n) also has its own subprocesses that form a system of subprocesses to achieve the set task (2):

$$A(0) = \left\{ \begin{array}{l} A(1) = A(1-1) + A(1-2) + A(1-3) \dots + A(1-n) \\ A(2) = A(2-1) + A(2-2) + A(2-3) \dots + A(2-n) \\ A(3) = A(3-1) + A(3-2) + A(3-3) \dots + A(3-n) \end{array} \right\} \quad (2)$$

The ability to continue any sub-process is usually the main criterion on which the individual characteristics of the socio-

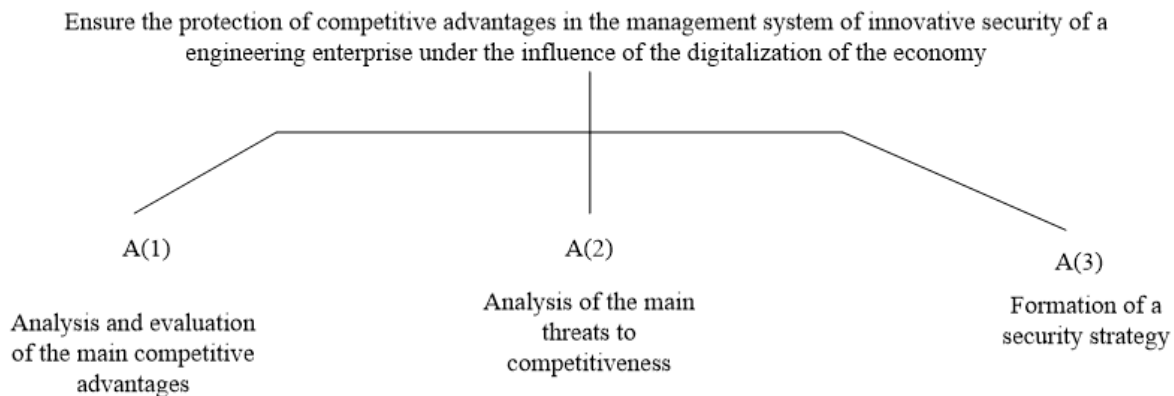
economic system and the environment for its functioning depend.

Of course, it is obvious that it is impossible to defend any abstract competitive advantages. A specific engineering enterprise should be taken as an example. It is proposed to take the engineering company Witkowitz (Czech Republic), which is suitable for a good example.

A characteristic feature of the description of IDEF0 processes is the clear identification of the advantages and disadvantages of the processes for protecting competitive advantages in the innovation security management system of a engineering enterprise under the influence of the digitalization of the economy. The works on the IDEF0 diagram are arranged as dominance - from the upper left corner of the diagram to the lower right. Either the most important work or the work done first is placed in the upper left corner. An arrow directed from the output of a higher work to the input or control of a lower one is a direct connection; an arrow directed from the output of the lower work to the input or control of the higher work is feedback. The absence of feedback, functions without output or control, duplicated functions make it possible to identify the imperfections of the analyzed processes for protecting competitive advantages in the innovative security management system of a engineering enterprise under the influence of the digitalization of the economy.

#### 4. RESULTS OF RESEARCH

Firstly, it is necessary to determine which subprocesses will accompany the achievement of the set task A(0) for the engineering company selected as an example. To do this, there are a number of sub-processes that will facilitate this. They are presented in the form of a graphical grid (Figure 1).



**Figure 1.** Graphical grid of subprocesses for supporting the solution of problem A(0) through the IDEF modeling technique for an engineering enterprise

A(1). Analysis and evaluation of the main competitive advantages. The saturation of the market with similar products and services, the competitive struggle between engineering enterprises for the consumer and limited resources necessitated the formation of competitiveness management systems. Depending on the field of activity, the level of competitiveness of an enterprise or its products is determined by a wide list of factors called competitive advantages. To improve the efficiency and optimize the management of competitiveness, it becomes necessary to highlight those parts

of it, the action on which will give the greatest effect. That is, there is an assessment of which elements give the maximum effect to an engineering enterprise and can be its main competitive advantages. In the case of Witkowitz, it should analyze and distinguish its competitive advantages in the foreign market from the domestic one.

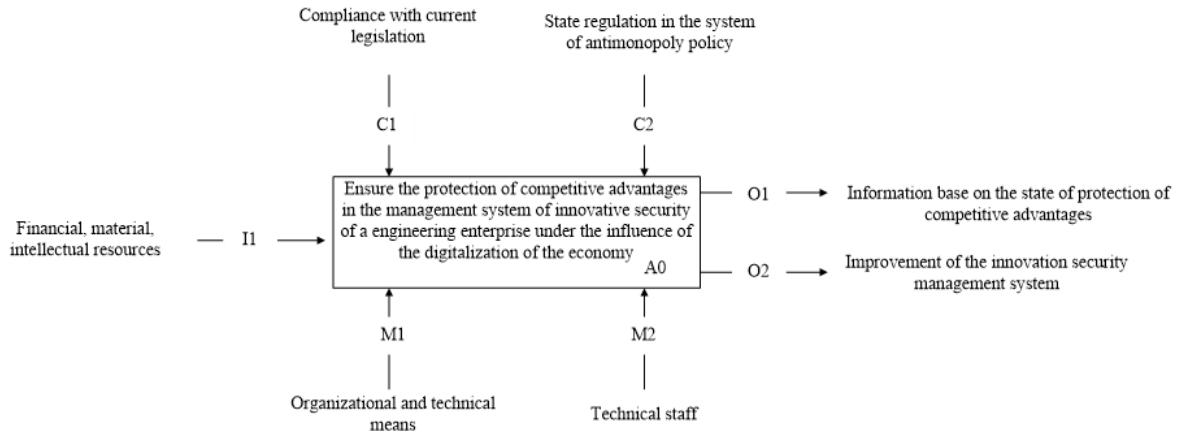
A(2). Analysis of the main threats to competitiveness. It is impossible to ensure the protection of competitive advantages for an engineering enterprise without knowing what external and internal threats are negatively affected. In the case of

Witkowitz, it is proposed to use mathematical modeling based on the method of hierarchical ordering according to the theory of graphs and connections. Through the involvement of experts and internal forces, a certain list of external and internal threats should be assessed and identified. Further, through mathematical modeling, streamlining their negative influence and gradually counteracting it.

A(3). Formation of a security strategy. In modern market conditions, the competitive struggle actually turns into a struggle of security strategies at almost all levels of management, and the implementation of competitive security strategies is the leading characteristic of the competitiveness

of all subjects of the engineering market. The main requirements for Witkowitz's competitive security strategy are to ensure its timely response to adverse environmental conditions and the ability of an engineering company to produce a competitive product. If these rules are not followed, then the competitive security strategy will not work, it will simply be unnecessary. Thanks to the previous sub-processes, it is possible to have the necessary information to form an appropriate security strategy to protect competitive advantages.

The next step will be the formation of an essential diagram of how the achievement of the set task A(0) for Witkowitz (Figure 2) takes place.



**Figure 2.** A graphic diagram of the essence of all elements of task performance A(0) for an engineering enterprise

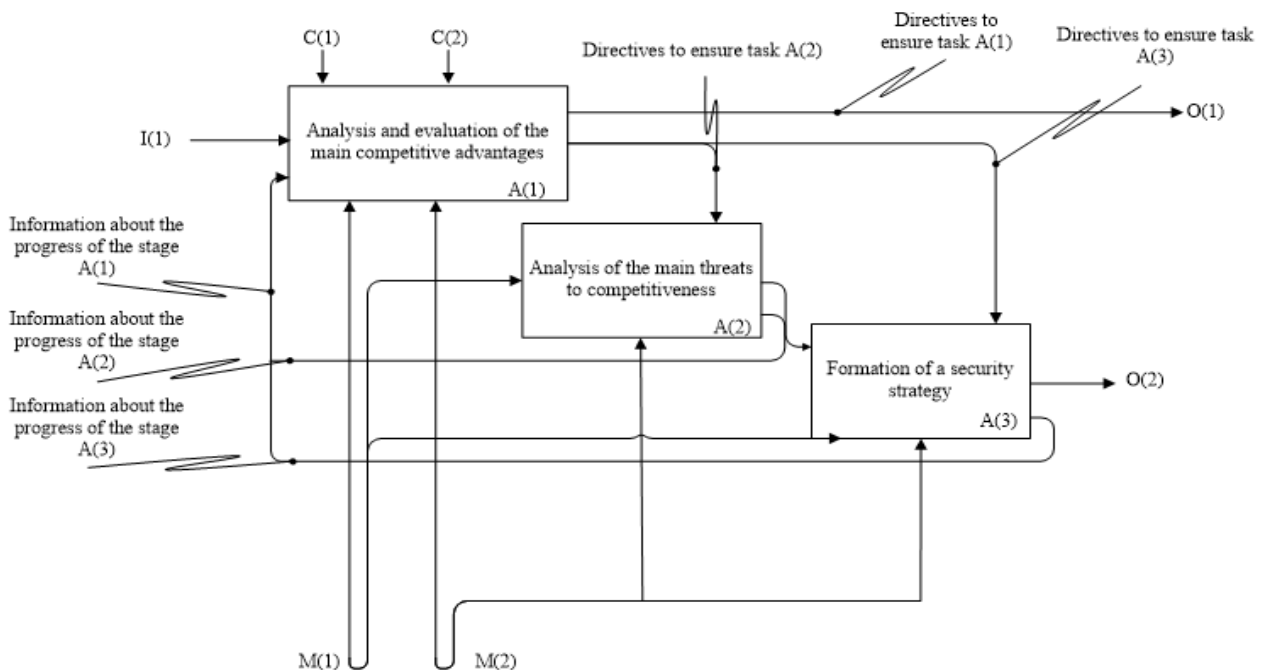
In general, regarding inputs I(1) and outputs O(1), O(2), it is not difficult to understand the process itself here, at the input we have resource support and not necessarily only financial, but at the outputs we get the desired result, which can be called socio-economic impact.

Usually, the implementation of task A(0) requires technical mechanisms (M1), (M2) that will help achieve the desired effect. But besides the auxiliary elements, the controlling aspects (C1), (C2) also play an important role, which include

legal norms and regulatory criteria that form a kind of corridor with non-overlapping limits.

All these elements will become part of the main model according to the methodical approach.

In general, it is necessary to present the main result of modeling the achievement of the set task A (0) - Ensure the protection of competitive advantages in the management system of innovative security of engineering enterprise under the influence of the digitalization of the economy (Figure 3).



**Figure 3.** The main result of modeling the achievement of the set task A (0)

Thus, we have the opportunity to model a model for achieving the set task A(0) through the implementation of all processes A(1). In the case of the engineering enterprise

Witkowitz, the key sub-processes A(1) will be those depicted in Figure 4.

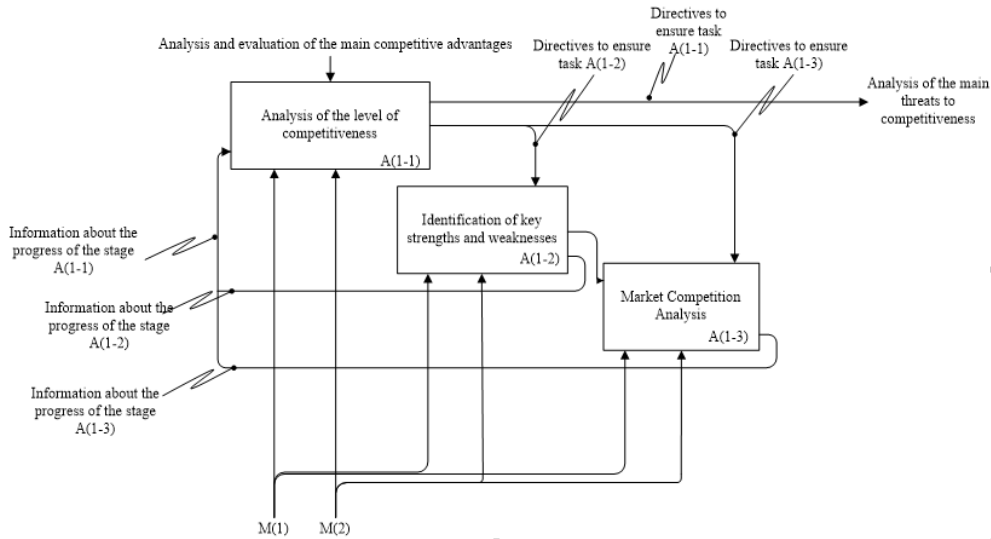


Figure 4. Results of modeling the achievement of the task A(1)

A(1-1). Analysis of the level of competitiveness. An important step is to analyze your own level of competitiveness. Unlike other financial and economic indicators, the level of competitiveness is a purely individual matter, which involves the use of those indicators that are best suited to a particular socio-economic system. The functioning environment of the socio-economic system, the conditions of its internal and external market, etc., should be taken into account. Determining your own level of competitiveness is a good start to form an understanding of your own competitive advantages, whether they are available at all. Because it is impossible to protect what is not.

A(1-2). Identification of key strengths and weaknesses. According to the results of the analysis of competitiveness, the socio-economic system can identify strengths and weaknesses. Strengths, in turn, fall under the category of competitive advantages that need to be protected. For Witkowitz, a strength is a positive internal tendency and characteristic of an institution that can be used to achieve strategic goals; an internal capability or resource that can generate a competitive advantage.

A(1-3). Market Competition Analysis. The competitive struggle is sometimes too fierce, in which the weak do not survive. For this, it is very important that the enterprise be ready for this struggle, that is, it has the appropriate levels of competitiveness and significant competitive advantages. The current competitive situation is becoming more complicated every year by expanding the boundaries of the market and attracting Western firms to it, which have significant experience in working in a highly competitive environment. That is why it is necessary to analyze the competition in the market. For engineering enterprise, this question has no boundaries. In modern conditions, the engineering sector of the economy is actively moving beyond the rule of two markets: internal and external. It's getting harder and harder to see the line between them.

Thus, we have the opportunity to model a model for achieving the set task A(0) through the implementation of all processes A(2). In the case of the engineering enterprise Witkowitz, the key sub-processes A(2) will be those depicted in Figure 5.

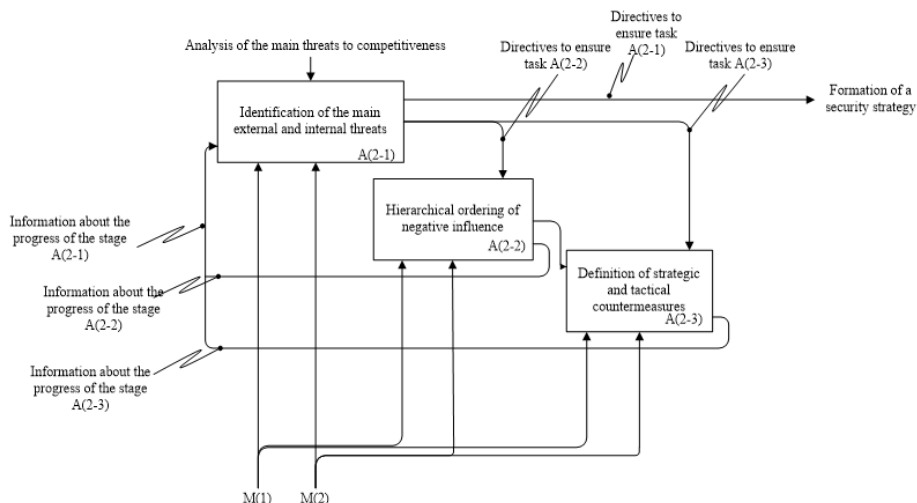


Figure 5. Results of modeling the achievement of the task A(2)

A(2-1). Identification of the main external and internal threats. Absolutely safe conditions for the activity of engineering enterprise do not exist, there are always threats that are either hidden or the company's specialists are not able to identify them. The threat to the activity of the engineering enterprise can become real. The threat to the enterprise does not arise by surprise, and the negative impact of its implementation is not an instantaneous event. Therefore, it is advisable to consider the nature of the threat to the activity of engineering enterprise, the reasons for its occurrence and development from the standpoint of the process approach, which is a new direction in the study of threats in the economic security of the microlevel. And also to identify the most influential threats.

A(2-2). Hierarchical ordering of negative influence. Thanks to modern econometric methods, one can easily determine which of the external and internal threats that pose the greatest

danger to an engineering enterprise. To do this, a connection and influence between certain threats is inserted through the theory of connections and graph theory. After that, through the application of the methodology of hierarchical analysis, the influence itself is ordered.

A(2-3). Definition of strategic and tactical countermeasures. Based on which external or internal threats have the greatest impact, the type of countermeasures is also determined. Those that have the greatest negative impact require the application of operational (immediate) countermeasures. Those that are the smallest need tactical and strategic countermeasures.

Thus, we have the opportunity to model a model for achieving the set task A(0) through the implementation of all processes A(3). In the case of the engineering enterprise Witkowitz, the key sub-processes A(3) will be those depicted in Figure 6.

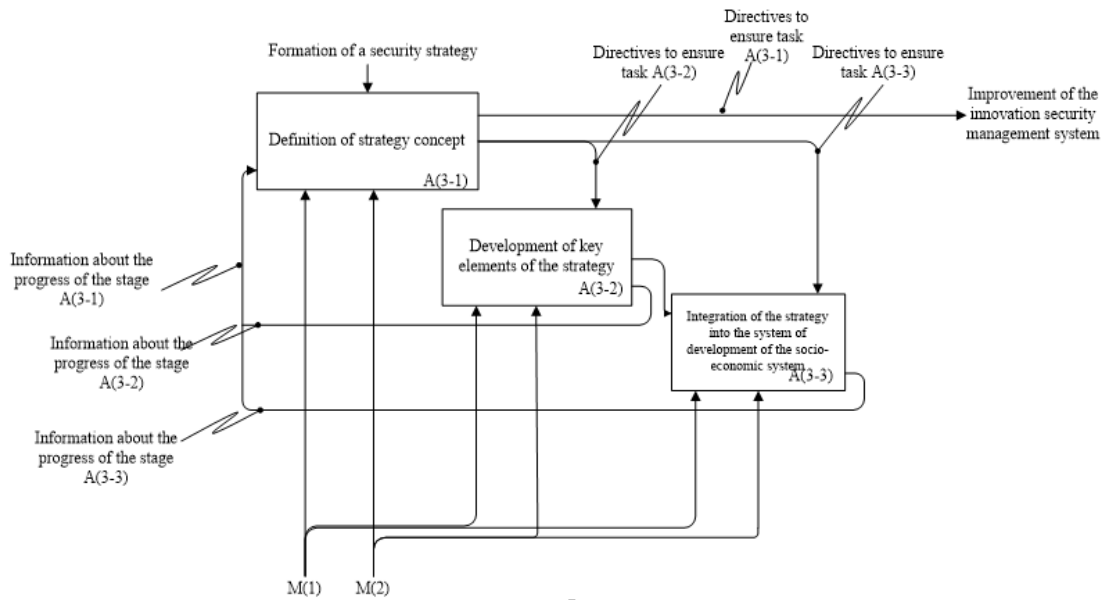


Figure 6. Results of modeling the achievement of the task A(3)

A(3-1). Definition of strategy concept. Початковим етапом в цьому складному процесі є формування самої концепції стратегії. Identification of its key aspects, advantages and disadvantages. Building the concept of a strategy for protecting competitive advantages for an engineering enterprise begins with the stage of analyzing the data obtained on the state of competitiveness and identified threats.

A(3-2). Development of key elements of the strategy. Any strategy involves a number of stages and measures. The strategy for protecting competitive advantages involves a number of elements and mechanisms that enhance its effectiveness. For an engineering enterprise, which is a complex socio-economic system, all key elements should be carefully developed.

A(3-3). Integration of the strategy into the system of development of the socio-economic system. The integration process is accompanied by several key stages, which include analysis and study of the readiness of the engineering enterprise for a new strategy for protecting competitive advantages. Further, through control and monitoring, its mechanism is implemented.

A key aspect is demonstrating an effective Witkowitz business model. Having singled out the innovation

management department at Witkowitz, we offered them to use our model in the formation and adoption of management decisions to develop and protect their own competitive advantages within three months (Figure 7).

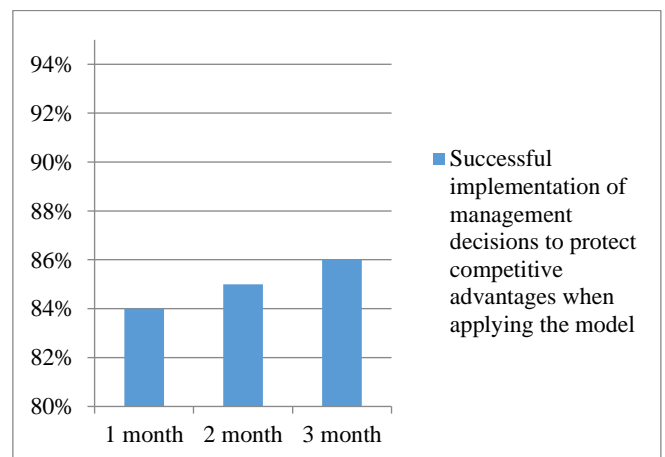


Figure 7. Dynamics of successful implementation of management decisions to protect competitive advantages at an engineering enterprise

Thus, we see that some changes in the success of the implementation of the decisions made using our model are observed. There was little time to quantify competitive advantages in this socio-economic system. This is a limitation of the study, which will be detailed in our future articles. These are only the first practical steps, but they already demonstrate the value of this methodological approach.

## 5. DISCUSSIONS

The article presents a theoretical generalization and a new solution of a scientific problem, which are manifested in the presented results. In the discussion, it should be noted whether our results differ from similar ones.

A significant number of scientists [13-15] focus on certain methodological tools for the formation of competitive advantages of enterprises in foreign markets in the context of key elements. In turn, we try to emphasize one methodological approach through modeling.

Some scientists [16-18] analyze the system of measures to ensure the most favorable environment for the formation of competitive advantages of enterprises in foreign markets. It is noted that: creation of a positive image at the international level; simplification of access of commodity producers to foreign markets; ensuring access of the studied subjects to imported production resources; development of innovative activity; attracting foreign investment will allow producers to improve the financial security and quality of their products, increase the volume of exports of products and, as a result, create competitive advantages in foreign markets. In general, we also try to offer favorable conditions for the management of innovation security through the very protection of competitive advantages, however, the emphasis is on engineering enterprise.

Some scientists [19-20] offer a list of recommended competitive strategies for practical application in foreign markets and highlight the requirements for each of them in the context of the following groups: export production volumes; the state of the material and technical base of the company; access to funding sources; innovative activity; compliance of products with international quality standards; location of facilities engineering enterprise; experience in foreign markets; product sales market.

The key difference of our research results is that we, through modern modeling methods, tried to present in a convenient, flexible graphical form the key stages to protect the competitive advantages of engineering enterprise under the influence of digitalization.

## 6. CONCLUSIONS

Summing up, it should be noted that the problem of ensuring survival and effective development is one of the main ones in the economic activity of enterprises, the solution of which directly depends on the ability of enterprise engineering not only to form competitive advantages, but also to keep them. In general, the competitive advantage of a product manufacturer should be understood as a set of main factors of its activity based on the use of existing potential and the ability of an engineering enterprise to make rational decisions regarding a quick response to changes in the internal and external environment.

The innovative activity of manufacturers of product engineering is a determining factor that forms their competitive advantages at different levels, because innovation improves quality and competitiveness, reduces costs and increases the efficiency of engineering enterprise management. Innovative activity is the end result of introducing innovation into the activity of engineering enterprise, which can contribute to the receipt of economic, social, environmental and other types of effects.

As a result, we presented the main model and its intermediate models, which detail the ways to ensure the protection of competitive advantages in the engineering enterprise innovation security management system. As an example of the effectiveness of the methodological approach, a real socio-economic system was chosen for the sample.

The study is limited. The key limitation is that competitive advantage is a complex and highly individual thing. They depend on the specifics of each engineering enterprise, separately. Further research should be devoted not only to ensuring the protection of competitive advantages, but also to the key tools for their development for the engineering sector of the economy.

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