# “Evaluation of innovative technology market potential on the basis of technology audit”


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# EVALUATION OF INNOVATIVE TECHNOLOGY MARKET POTENTIAL ON THE BASIS OF TECHNOLOGY AUDIT

## Abstract

Enterprise innovation activity supposes coordinated technical and business processes of decision-making and its performance required for successful transformation of new product or service from concept to market. The purpose of this study is to develop valuation methods of innovative technology market potential and prospects of their introduction into the production enterprise activity.

In order to achieve this goal, we used brand new evaluation tool, this is technology audit conception, application of which increased significantly the accuracy and reliability of technology market potential evaluation. Clarification of terminological essence of technological audit allowed the authors to discover the content of technology audit components required for the market research and thereupon to develop evaluation mechanism for innovative technology market potential using technology audit. This mechanism is built on structure evaluation table of technology market potential level detection as an object of commercialization. To ensure the efficiency of practical effect of the mechanism proposed, the authors systematized and completed methods of functional analysis and scanning of market environment for the purpose of qualitative comprehensive evaluation and innovative technology market potential forecasting.

Introduction of the proposed evaluation method for technology market potential will result in the improvement of efficiency of enterprise innovation activity due to more rational distribution of available resources and immediate financing of developments with greater market potential.

**Keywords** technological product, market, commercialization, capitalization, economic effect, evaluation

**JEL Classification** M31, O32, O33

## INTRODUCTION

Commercialization of innovative technology is a basis of efficiency of the intellectual and innovation activity results, creative achievements of any enterprise or organization. But it is incredibly hard to foresee performance of market outlook of any innovative solution at the stage of its creation.

Innovation world statistics points to the fact that eighty per cent of new companies wind up a business in five years after their establishment because of the fact that their product has no market outlook. Whereby, 90% of innovative solutions of great companies never become a commercial product (De Prato, Nepelski, & Piroli, 2015). According to the Australian Bureau of Statistics after the establishment of 316 850 new small enterprises, in 4 years, only 48.6% could survive (Levie, 2012; Trinci, 2018). Modern statistics is that among 15 projects just one can be successful, 4 will bring some income, 6 of them will overcome break-even point, and 4 more will not satisfy expectations absolute-



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ly and will be closed (Nepelski & Piroli, 2018). According to expert evaluations, only 45% innovative companies enter the stage of sales, although they have got a qualitative business plan in 60% of cases (O'Donnell, 2019). According to research of Nautech Consulting Company, often start-ups die out due to reasons within and beyond the developers' control, for example, bureaucratic red-tape, overwhelming tax burden for "new-born" enterprises and imperfection of innovation legislation (Mazzucato, 2016). If we analyze world statistics for the last few years related to survivability of high technology start-ups, so, notwithstanding the data inconsistency given by the foreign and Ukrainian experts, the survivability of newly-established innovative companies is very low (Poberezhna & Pererva, 2012). That is why establishment of a new company is a risky process which requires special and competent efforts. Such kind of efforts shall, in our opinion, be made by technological parks, incubators, subdivisions, engaged in marketing, transfer of technologies, which help to make decisions on commercialization of developments, following on from the results of marketing, economic, technology audit. Therefore, extremely important and urgent task of each developer of innovative solutions is forecasting their market (commercial) potential.

## 1. THEORETICAL FOUNDATIONS

Improvement of effectiveness of innovation process is closely associated with the processes of transfer and commercialization of pieces of technology, as evidenced by numerous publications of leading scientists in the innovation branch (Astebro, 2004; Bart de Vries, 2011; Beers & Zand, 2014; Kocziszky et al., 2012; Maslak et al., 2008; Mazzucato, 2016; Nepelski & Piroli, 2018; Nepelski et al., 2019). Technological potential of machine-building enterprises has no substantial prospects without intellectual innovative component, without development and application of innovative technology (De Prato, Nepelski, & Piroli, 2015; Evanschitzky et al., 2012). In world practice, industrial enterprises use various methodological approaches which allow, firstly, to evaluate commercial opportunities of different sides of innovative solutions (Mazzucato, 2016), secondly, to compensate disadvantages of every existing method (Kosenko et al., 2018). As one of main tools for evaluation of innovative technology market potential we often use LIFT methodology (Linking Innovation, Finance and Technology). The methodology was developed during the Fifth Framework Programme of the European Community for Research, Technological Development and Demonstration Activities – FP5), being held from 1998 till 2012 (Kelessidis, 2000; Kvashnin, 2006; Pilnov et al., 2006). In general, LIFT methodology is an expert innovative project selection method for their financing. Evaluation is carried out according to classical scheme: information collection (interview) – analysis – report preparation. According to this methodology, an enterprise invites a team consisting of three experts for interviewing (duration of interview is approximately two hours). Preliminarily an enterprise obtains questionnaire on commercialization project (one questionnaire per one project) to be completed during three business days from the date of its receiving and sent back to experts. In our opinion, use of independent experts, as well as immediate expertise, is a positive side of this methodology, many researchers agree thereupon (Levie, 2012; Nagy, 2012; Nepelski et al., 2019; Tkachev, 2017). But drawing a final conclusion only in minds of experts can bear significant risks, presence of which can cause essential financial losses and loss of property for enterprises. Disadvantages of LIFT methodology were partially eliminated in another guidance paper – TAME (Technology and Market Evaluation) methodology, which was proposed by Lambic Innovation Ltd (Pilnov et al., 2006). The distinction of the TAME methodology from the LIFT methodology consist in that the emphasis is upon the evaluation of innovative technology potential sales markets (Mcclure, 2011). Definition of the level of innovative technology market potential according to the TAME methodology is based on the system approach to evaluation of innovative solutions and their commercial potential and includes key factors of success of piece of technology. As evidenced by the foreign experience (Trinci, 2018; Mcclure, 2011), TAME model application when defining technology market potential provides: capabilities and power of rights of intellectual property; technology nature

(completeness, novelty, available standards); introduction of technology (resources, infrastructure); technology support; commercial aspects (segments, scope of market, peculiarities and reaction of consumers, their needs, alternative competitive projects, competitive positions, market share). Attention focusing on a small amount of key market factors and expansion of inter-organizational interaction when implementing technology commercialization programs points to significant results in the reduction of costs, introduction of ecological initiatives, increase in efficiency and adaptability to changes and support of competitive ability of innovation developer (Pilnov et al., 2006; Levie, 2012; Trinci, 2018).

Decision-making procedure related to innovative solution and commercialization of piece of technology is not always based on rates of the future technology market potential level. Not least important is expenditure rate which has to be carried out prior to its achievement. In many cases, such an expenditure level is not available for developer. In our opinion, taking into consideration this factor when evaluating market potential of piece of technology is quite important. World practice of technology transfer proposes to use an evaluation method for technology market potential from the perspective of value approach (Cooper & Edgett, 2008; Evanschitzky et al., 2012). Target of evaluation like that is an ability to create value. Therefore, innovative development goal is focused on the achievement of economic result and corresponds to market approaches to market potential evaluation. However, from the perspective of ways to reach goals, the work thus focuses on resource allocation analysis. The method defines condition that market potential generates all available resources. As an analysis method it is proposed to define function elasticity growth of key performance indicator when changing factors defining it. On the basis of business plan analysis as a key rate that reflects purpose, one chose an economic value-added rate. It is evident that this approach does not allow to evaluate an innovation market value growth potential. Evaluation of the significance of individual indicators-factors is not identical to measuring the growth potential of the innovation developer resources cost. This cannot be regarded as acceptable, since the strategy of innovation development can be associated with the change of business model and as a consequence the structure of resources consumed is changed. Some resources (among available) can become excessive, and another can be insufficient. A lot of researches (Bart de Vries, 2011; Beers & Zand, 2014; Cooper & Edgett, 2008; O'Donnell, 2019) pay attention to the fact that major disadvantages of resource concept when defining innovation market potential is that study of developer's innovative technology resource potential and his evaluation characterizes only its inner opportunities and doesn't reflect market conjuncture and almost ignores market component.

Enterprise level – developer of piece of technology – does not always adequately reproduce market opportunities of innovation technology. In some circumstances, it is required to be oriented not only to the opportunities of a certain enterprise, but also to the level of branch, region, corporation. The Ukrainian practice of commercialization of innovation technologies proposes to use "innovation lift" with its components – business workshops, business incubators, science parks, industrial parks/European technological parks – as a tool of development of small innovative enterprises, new types of activity and sectors of economy (Lyashenko, Pidoricheva, & Petrova, 2017). The goal of "innovation lift" is to increase education quality, development of entrepreneur and innovation-oriented culture of region, development of continuous wave generation system and commercialization of scientific ideas from school to industry to undergo the most risky stages of innovative chain in order to increase a flow of qualitative innovative projects, ready for investing by means of providing access to required resources and competencies. All of these things according to conceptual provisions of this method provide a high level of market potential both of the innovative projects themselves and systems within which they were developed. Without denying "the innovation lift" concept as a whole, let us note that it is peculiar and efficient for regional systems to the maximum extent, but for the enterprise level it bears declarative nature to some extent.

First, an idea to evaluate innovation market potential using technology audit concept was considered in the scientific works of Kelessidis (2000), Pilnov, Tarasova, and Yanovskiy (2006), Mcclure


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(2011), Trinci (2018), Tkachenko, Rogova, and Osipenko (2018). But the consideration of the technology audit idea itself doesn't allow to use it in practice. There is a vital need in development of methodical tooling of quantitative evaluation of innovative technology market potential using the technology audit concept, definition of the most important (key) rates of market and technologies, which shall be taken into account during the quantitative evaluation of market potential of piece of technology.

Comprehensive study of problems related to the innovation market potential evaluation allows for the conclusion that from a theoretical and practical perspective within the innovative technology commercialization management on the basis of technology audit, an option of forecasting purposive approach to the evaluation of innovation market potential attracts the most interest, which foresees determination of enterprise market cost growth potential and resource efficiency evaluation that corresponds with resource market value approach.

## 2. RESULTS

Economic substance of commercial realization of innovative activity relations and intellectual property objects created as a result of their implementation, in our opinion, consists in income generation. Income generation form in this case is defined by double nature of innovation technology. On the one hand, innovative technology can serve as factor of production, being a part of resource potential of enterprise or its intangible assets. On the other hand, innovative technology can be independent object of sale, in other words, be a good. Moreover, both variants of using the results of innovative activity can be equally efficient. Trading income from practical realization of innovative technology is closely related to its market (commercial) potential. It is proposed to define a level of market potential of piece of technology as market volume, that is such an amount of innovative product or technologies, which can be sold during a year in the market at current market prices.

Commercial realization mechanism of innovative technology market potential is shown in Figure 1.

During the process of commercialization of innovative technologies as factors of production intangible assets validity transfer to the product value takes place, in other words, the capitalization process is carried out. In this case, an income will be a part of profit from the sales of finished products, created using innovative technologies. Realization of economic interests of owner of intellectual, creative activity results is possible not only at the stage of production, but also during the exchange process by means of commercialization of innovative technologies. Upon such transfer of rights, income occurs in the form of proceeds from marketing the object itself or particular authorities from the bundle of intellectual property rights (Mcclure, 2011). Capitalization and commercial use of innovative technologies provide significant economic effect shown in Figure 1.

Market relation development in our country's economics forms new perception of intellectual property as huge economic and scientific and technological potential, able to rise both country's economics and individual industrial enterprise. For efficient economical advance of industry sector, it is required to create forcible progressive technology commercial potential evaluation mechanism, modern equipment that will ensure their efficient distribution and use. As a practical mechanism of technologic policy activization in scientific and technological and production sphere it is proposed to use technology audit.

In available scientific literature, researchers propose a number of definitions of the technology audit term (Kelessidis, 2000; Pilnov, Tarasova, & Yanovskiy, 2006; Mcclure, 2011; Trinci, 2018; Tkachenko, Rogova, & Osipenko, 2018). Some of them radically differs from each other that makes it impossible to present this category as an integral object of research. Ambiguousness interpretation of "technology audit" term is connected with its relative novelty, since in Europe it began to be used only from the beginning of the 90s of the twentieth century, and in our country its practical use only starts. The studies point to ambiguous understanding and use of technology audit at enterprises. We highlighted three directions, which were the most in-demand for this unique economic approach and demonstrated in Figure 2.

Source: Proprietary solution.

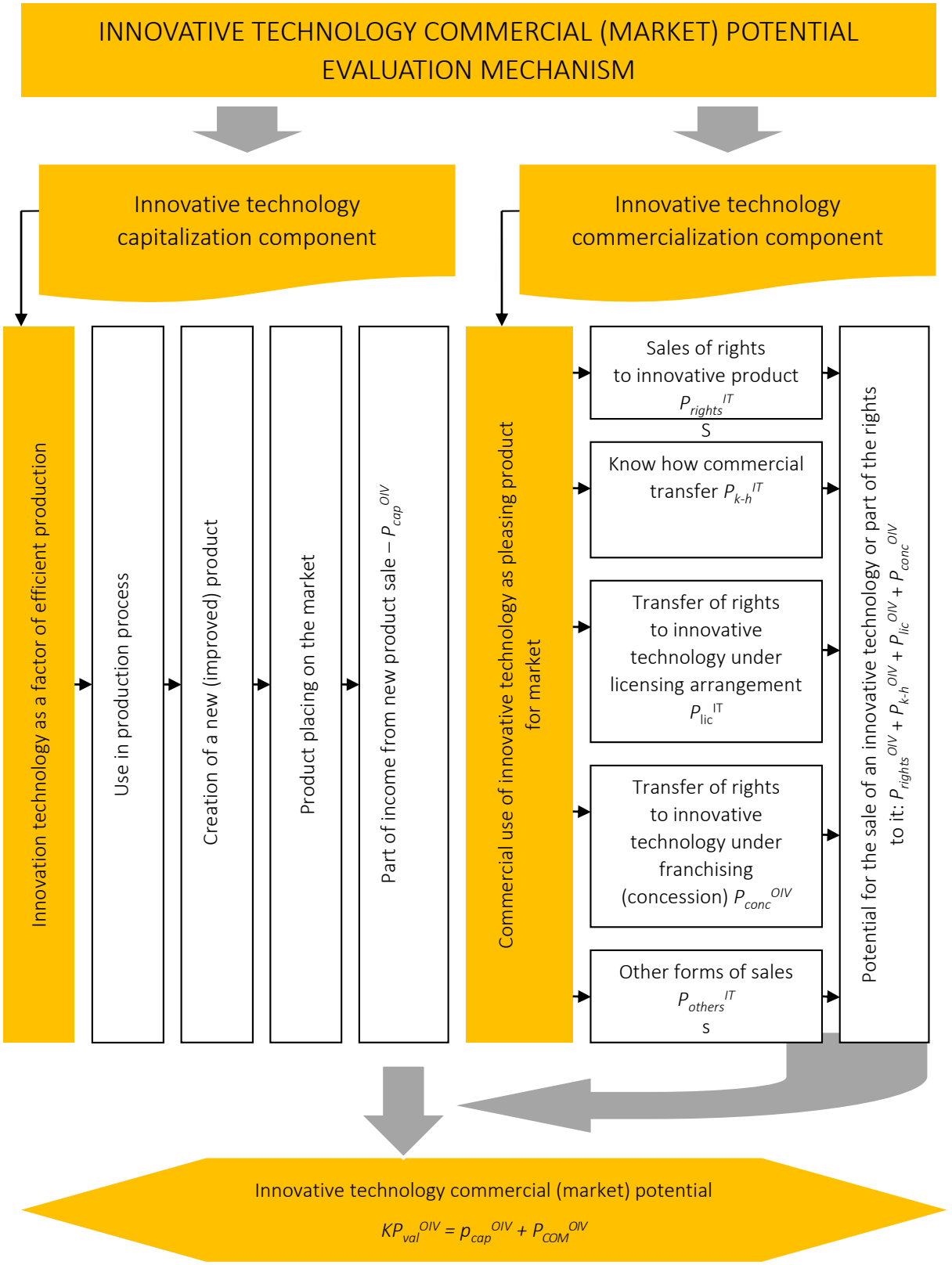


**Figure 1.** Practical realization mechanism of innovative technology market potential



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Source: Proprietary solution.

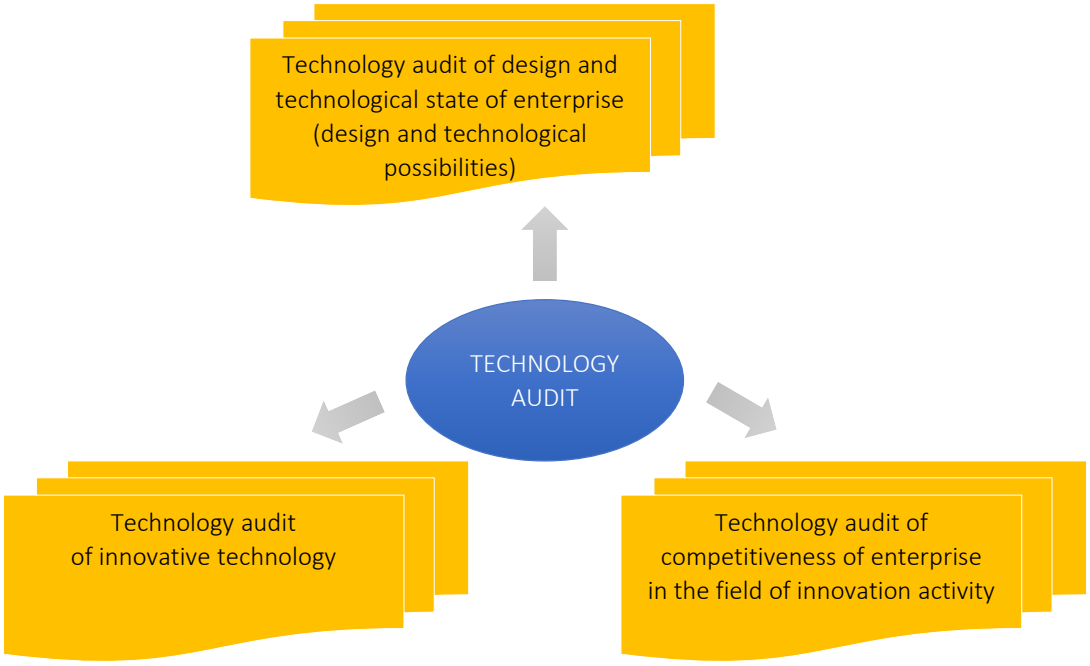


**Figure 2.** Triad of courses of technology audit at industrial enterprise

Most commonly technology audit shall be understood to mean substantive evaluation of enterprise for the purpose to find out technology and evaluation of its potential as an object of commercialization. In the native literature when researching provisions of technology audit, the emphasis is made on checking technological processes, methods, procedures, which are used in organization in order to evaluate their efficiency, not giving pride of place to the matters of commercial opportunities of piece of technology.

As a result of critical analysis of definition of terms "technology audit", it is proposed to use the definition as follows: technology audit (technology assessment) is a system of informational and analytical, methodologic and tooling evaluation of commercial potential of innovative products developed or applied at enterprise in order to ensure their efficient external and internal transfer.

Technology audit allows forecasting commercial potential of new developments, managing all process of promoting progressive technologies into markets. Transformation of research and technology into modern progressive solutions suitable for production and market is one of the most complicated stages that tie together science and consumer. As yet native enterprises have little experience in managing technological enterprise, have no appropriate methods and regulatory materials, which govern use procedure and methods of evaluation of high technologies upon their commercialization. For successful commercialization of scientific research results and developments, it is required to carry out expert analysis and their selection taking into consideration both world and national consumer demand. They shall have usability and demand potential in the market economy environment that is responsible for currentness of scientific research in this regard.

On the basis of these grounds, we deem it advisable to form structurally logic chart of technology audit of innovation technology (Figure 3).

The proposed conceptual diagram of technology audit (Figure 3) differs fundamentally from existing models, which as a whole emphasizes the organizational component of technology audit (who carries it out, expert team formation, definition of key components of audit, appraisal by points of their state, general conclusion, report preparation). In our opinion, technology audit shall include much higher number both of lines of research (technical, legal, marketing, econom-

Source: Proprietary solution.

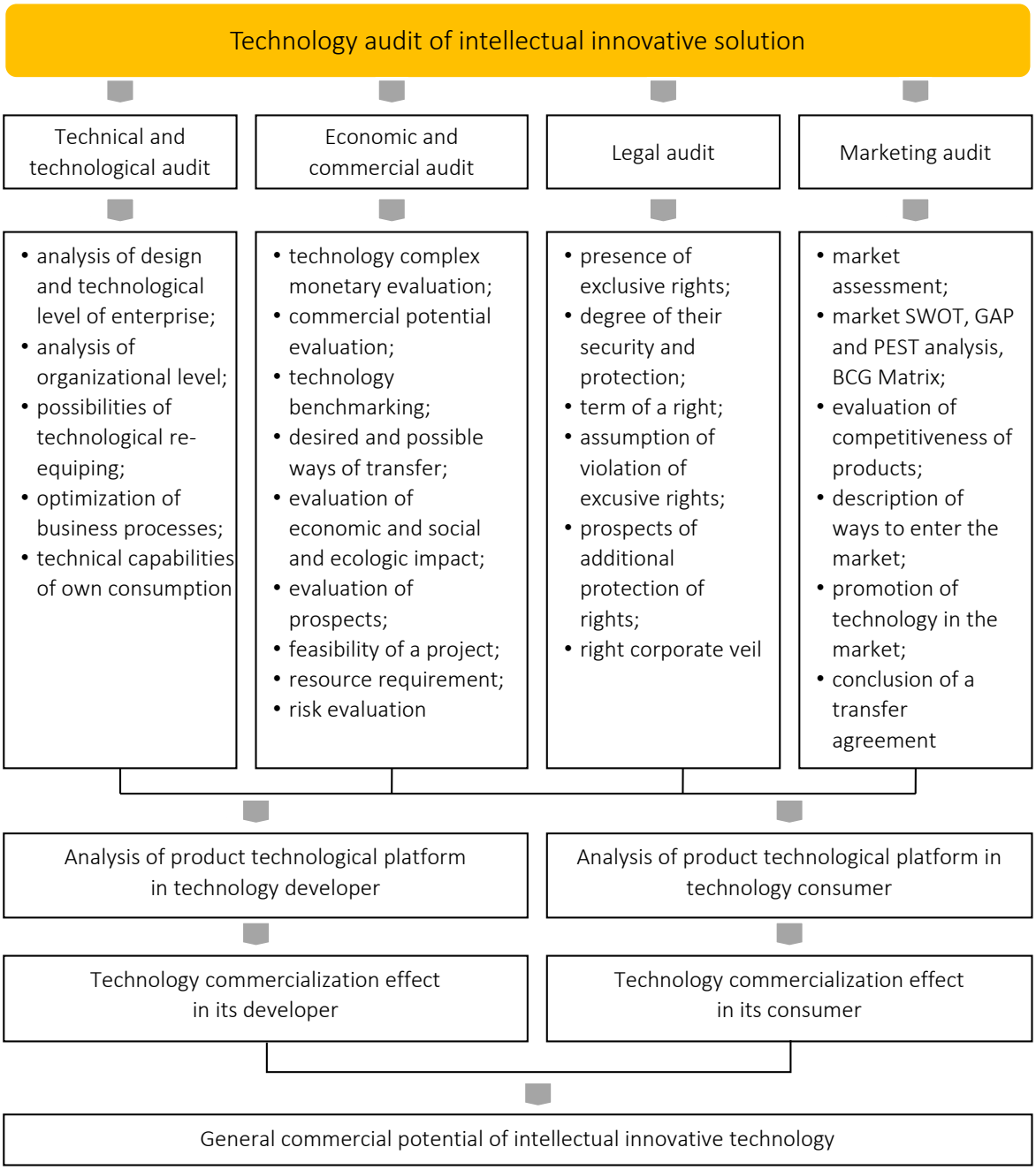


**Figure 3.** Structural logical (conceptual) scheme of technology audit of innovative technology

ic, technological), and shall foresee use of modern tools of analysis and evaluation of piece of technology. Such tools, in particular, shall include PEST analysis designed for discovery of political, economic, social and technological aspects of environment, which can influence the development processes, promotion and consumption of development; SWOT analysis which enables to build a strategical balance of negative and positive factors and define (in basic terms) a company's corporate strategy concerning the development promotion taking into consideration an impact of ambient and internal environment simultaneously; GAP analysis which defines strategic distinction between the desired (what an enterprise desires to achieve in its development) and realistic (what actually an enterprise can achieve not changing its current policy) and affords on the


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basis of study of actual and potential flows of income from production and realization of various kinds of products to find out weak points (unfamiliar areas) of market which can be filled with new products; BCG Matrix which allows soundly defining market position of piece of technology, etc.

The practice of carrying out qualitative comprehensive evaluation of market potential of innovative technology is based on three groups of methods, theoretical and methodological essence of which, in our opinion, can be narrowed down to the following provisions.

1. *Environment scanning methods*, where the results of marketing analysis of real and future of market of technologies, possible consumers and competitors are reproduced. Among possible sources being used when scanning environment, there are major, secondary and "the third wave" ones. Sources of "the third wave" of environment scanning is specific procedures and searching tools which will be applied only upon inspiring results of the previous evaluations when using major and secondary sources.

2. *Functional analysis method.* A group of these methods takes an essential place in the evaluation of consumer characteristics of new product and technology, as well as their competitive ability. During such an analysis a product or technology is being considered as a system or system of elements (subsystems) designed for performing desired functions.

**Table 1.** Evaluation table of innovative technology market potential as an object of commercialization on the basis of technology analysis

Source: Proprietary solution.

| Grades | | | | |
|---|---|---|---|---|
| **0** | **1** | **2** | **3** | **4** |
| **1. Concept of technical realization** | | | | |
| Certainty of concept is not confirmed | Concept is confirmed by expert opinions | Concept is confirmed by calculations | Concept is experienced | Functionality is checked under real-life conditions |
| **2. Market advantages** | | | | |
| Many analogues in small market | Not many analogues in small market | There are analogues in large market | There is one analogue in large market | Product has no analogues |
| Product price is very high | Product price is higher than analogue's one | Product price is the same as analogue's one | Price is lower than the analogues' one | Price is much lower than the analogues' one |
| Product features are much worse than analogue's ones | Product features are a little bit worse than analogue's ones | Product features are similar to the analogue's ones | Product features are a little bit better than analogue's ones | Product features are much better than analogue's ones |
| Operating costs are much higher than analogue's ones | Operating costs are a little bit higher than analogue's ones | Operating costs are similar to analogue's ones | Operating costs are a little bit lower than analogue's ones | Operating costs are much lower than analogue's ones |
| **3. Market possibilities** | | | | |
| Market is small and doesn't have positive dynamics | Market is small, but it has positive dynamics | Average market with positive dynamics | Big steady market of products under this tehcnology | Big market with positive dynamics |
| Very active competition | Active competition | Moderate competition | Insignificant competition | There are no active competitors |
| **4. Practical feasibility** | | | | |
| There are experts | It is necessary to hire experts | It is necessary to train experts | Moderate training of experts | There are experts for implementation of such an idea |
| Considerable financial resources are needed, there are no sources | Minor financial resources are needed, there are no sources | Considerable financial resources are needed, there are sources | Minor financial resources are needed, there are sources | No additional financing is required |
| New materials have to be developed | Materials required are hard-to-find | Expensive materials are required | Materials for idea implementation are cheap and achievable | All materials have been already used in this production |
| Protocols and many approval documents are required | A large amount of approval documents is required | Getting approval documents requires insignificant expenditures | Only notice for certain bodies responsible for product production and sales | There are no restrictions to production and realization of product |

3. *Estimating and forecast procedures.* For successful commercialization of technology, it is required to foresee how and what changes of market can have an impact on a particular business. The technology commercialization efficiency or even possibility of its implementation depends on how successfully one can forecast or how quickly define the first features of market changes occurring. Estimating and forecast procedures include a variety of methods being used for the purpose of forecasting not only for technologies and pieces of technology.

Results of technology audit are recommended to present in the form of evaluation table which appears as follows (Table 1).

Upon successful completion of technology audit, report and recommendations containing therein are discussed with the enterprise's management team responsible for efficient implementation of chain of measures: decision making – approval of plan of actions – execution of actions. The most important task of technology audit is optimization of innovative flow of commercially advanced development. As a result of conducting and obtaining expert opinion, one composes a plan of actions related to the increase of efficiency of the innovative technology use, forms a package of business proposals and recommendations.

## 3. DISCUSSION

Complexity related to determination of innovative technology market potential under the conditions of a limited number of output data results in natural necessity to develop and use adequate methods, procedures and models solving problems of efficient commercialization of innovative technology. Problems concerning innovative technology transfer in these recent times are in the zone of special attention of many researchers. Analysis of existing ideas as to methodological approach to determination of innovative technology market potential led to the conclusion that:

- regional, industrial, innovative technology market potential intergovernmental valuation models cannot be used in full for appropriate estimations at enterprise's level;
- the most accurate results of technology market potential estimation can be obtained using technology audit conception;
- in a majority of organizations when studying technology audit provisions these days an emphasis is made on checking technological processes, methods, approaches and procedures without paying enough attention to the issued related to commercial opportunities of piece of technology.

Notwithstanding existing achievements and significant contribution of the native and foreign scientists into the development of technology audit major provisions, the theory and methodology of its use for needs of innovative technology commercialization in the unsteady market environment are still underdeveloped. In particular, problems of practical use of technology audit conception in innovative activity of industrial enterprises are considered fragmentarily (Abdel-Razek & Alsanad, 2014; Bart de Vries, 2011; Kelessidis, 2000; Trinci, 2018) and in a majority of scientific works predominately bears general nature (Mcclure, 2011; O'Donnell, 2019; Pilnov et al., 2006). The absence of comprehensive approach to technology audit use for purpose of development methods of innovative technology market positioning does not allow choosing efficient variants of its commercialization, especially when transferring technologies at the international level.

Notwithstanding a wide range of various opinions of innovative technology commercialization process researchers, we shall note that technology audit plays an important role in enterprise's technology policy. As a rule, by means of technology audit one tries to activate inner, hidden reserves of enterprise for increase in profits and improving the profitability. In this case, industrial enterprise uses classical model of enterprise. But let's not forget that technology audit has features of innovation process: individuality, creative approach to solving set problems, carrying out comprehensive research, etc. Result of technology audit can be introduction of new types of goods and advanced technologies, including on the basis of already ex-


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isting ones. And these are features of innovations, smooth transitioning from classical model of enterprise to innovative model.

Technology audit doesn't still occupy in our industry a place which belongs rightfully thereto. But, in our opinion, when used appropriately, this scientific conception will become immensely useful and beneficial for all participants of technology market. We believe that the use of technology audit is quite progressive trend of improving efficiency and productivity of innovative solution commercialization processes at industrial enterprises. Development of commercialization management mechanism intellectual property and technology on the basis of technology audit is extremely important theme for scientific research, reflects present-day realities, agrees with objectives of economic development of Ukraine and tasks set before enterprises and organizations having achievements in intellectual sphere.

## CONCLUSION

According to the results of the study undertaken, we can draw a conclusion that evaluation of innovation market potential is a challenging problem having no unambiguous solution that is based on use of various approaches and methods of evaluation. This conclusion appears from the conducted analysis, as well as from the developed innovation market potential evaluation system conceptual model, summary of the results of research. Taking into consideration that the target of evaluation of innovation market potential is formulated by authors in various manners, it is obvious that every analyst can use own approach according to the defined targets of evaluation. However, in our opinion, innovation market potential evaluation has the most significant value when developing and implementing strategy of innovative development of enterprise. On the basis thereof, we believe that innovation market potential evaluation as a growth potential defined as a part of value approach using economic value-added criterion is of great interest. The most reasonable solution for this problem in our view is technology audit that allows not only to define potential of growth, but also to evaluate efficiency of enterprise's resources use. This allows within dynamic opportunities of management to define hot topics of business model improvement, enabling thus to eliminate defects and to improve efficiency of resource usage. Use of this method meets the requirements of resource and market cost-based approach, allowing to obtain forecasting evaluation of potential for economic growth and strengthening competitive capacity to enterprises, that corresponds to the central goal of strategic management in innovation process.

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