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## SELECTED ASPECTS OF THE VALUATION OF INNOVATIVE UNDERTAKINGS

The paper presents a review of selected approaches and methods of the valuation of innovative undertakings useful for effective innovation management. These methods are based on the concept of the so called staged valuation process. The method of valuating outcomes of an innovative project within a commercial enterprise is presented within the framework of economic assessment of an innovative project. The duration of the competitive advantage achieved due to the implementation of innovations in a company can be one of the methods of measuring gains from innovation. This indicator can be widely applied both for a leader that leaves the competition behind due to the effect of an innovative project and for a company that reduces the distance separating it from the leader.

**Keywords:** *innovative project, methods and indicators of valuation*

### 1. Introduction

The realisation of innovative undertakings (projects) requires good management, as well as considerable material expenditure. Material expenditure may be limited in the initial stages of undertaking as the work progresses to further stages. However, expenditure increases significantly and reaches its highest value at the stage of industrial deployment. It is rare that all stages of an innovative project are carried out by one entity with a uniform ownership structure. Sometimes, even in the initial stages of a project, there arises the need for technology transfer between entities. This transfer can be carried out in various ways, yet it always requires – to a smaller or larger extent – project valuation at the stage when the transfer occurs. The aim of this paper is

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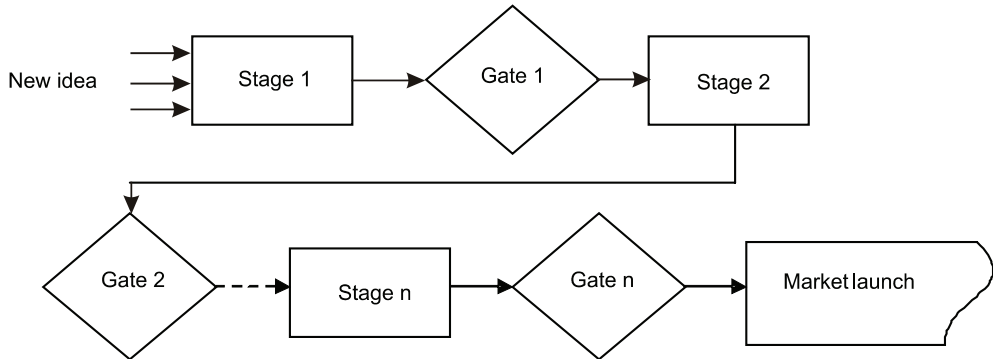
a review of selected approaches and methods of the valuation of innovative undertakings that are useful for effective innovation management, as well as the presentation of one of the methods of valuating innovation based on the concept of competitive advantage. The valuation of innovation is always based on the assessment of innovation potential. Although innovation potential can be valued by a large variety of analytic and synthetic indicators ([16] p. 93–120), valuation must result in the estimated value of this potential.

## **2. Selected concepts of the valuation of an innovative undertaking**

Research institutions and enterprises that aim at effective management of innovative undertakings concentrate on finding projects with high technical, market and economic potential ([11], p. 28–29). In this respect, generating and valuating a large number of ideas/concepts – out of which only the most attractive projects will be selected in the process of valuation – is a fundamental issue. Clearly, one of the main problems is efficient elimination of unattractive projects that will not yield appropriate outcomes for the institution implementing the project. This process, however, is problematic as a certain contradiction arises. On the one hand, the realisation of ineffective ideas takes time and money, on the other, a detailed analysis of an undertaking is also costly and absorbing (expert valuations, market research, etc.) ([3], [1], p. 175).

Many interesting methods have been published to measure and value the innovation potential of research project outputs. The concept of the so called “idea funnel” is frequently used ([7], p. 98–99). The funnel has a wide inlet into which many ideas fall, often immature and unpolished. Initially, they undergo only a general selection. As work progresses however, the criteria become more detailed. Thus, unattractive projects are gradually “whittled out” and only the ones that are market-ready, in one way or another, remain.

The system of “stage-gates” (stage-gate process) created by Cooper [4] at the end of 1980’s is an enhancement of the idea funnel concept. It is a particular pattern of conduct that shapes the direction of all the actions connected with a new technology or product. A project is divided into stages, also known as phases, and gates that close each stage and determine further work on the project (see Fig. 1). This means that at the end of each stage, a yes/no (go/no-go) decision should be made, in other words whether to reject (stop) or continue the project. Progress to each successive phase should reduce uncertainty and provide people deciding on the fate of the project with the information necessary to make the decision of whether to pass onto the next phase or quit the project.



**Fig. 1.** The concept of a stage-gate process.

Source: Based on Harvard Business Essentials 2005, p. 102

The system of stages and gates encompasses the phases of the idea (technology) development process – from polishing a raw idea, technical specification, product construction to its commercialisation. The number of phases and gates, as well as their characteristics, depend on numerous factors, among others, on the complexity of the technology and the risk involved, the scale and objective of the project, the strategy of the institution implementing the project, its organisational and competence capacity. They should be, however, arranged in such a way that the necessary information – technical, market, financial and operational – can be collected to assess the technical and market risk connected with the project. Each successive phase costs more than the previous one, which means that the process of valuation assumes the growing involvement of resources and time corresponding to the completion of successive stages of valuation ([1], p. 183–186). Using this system, gates are treated as checkpoints at which decision makers choose whether to quit the project, leave it at its current stage or move it forward to the next one. They serve to evaluate the compatibility of an idea with the strategy and objectives of the project and to assess whether the idea meets certain technical, market and financial criteria, as well as whether the idea can be tested and go into production. The structure of each gate is similar and consists of three elements. Its fundamental part is comprised of the information and assumptions necessary to draw up an analysis report. These are divided into sheets corresponding to particular subject areas of the report. The further parts are comprised of the criteria and procedures for the valuation and its outcome. A member of the institution's management usually supervises the stage-gate – particularly in terms of the resources required and the composition of the valuation team ([4], p. 200).

The concept of a stage-gate process encompasses the so called R-W-W (real, win, worth it) screen, proposed by Day [6], which estimates the probability of the success of an innovative product idea. It is a simple tool, based on a series of questions about the idea or product, its potential market, as well as the company's potential and its

competitors which can be used during the individual phases of product development, in order to: (1) detect false assumptions, knowledge shortages and potential sources of risk, as well as (2) ensure that no opportunity to create an innovation has been missed.

The method of assessing the degree of implementation maturity (DIM) created by the team at the Exploitation Technology Institute, National Research Institute, in Radom ([13], p. 1–5) can be particularly useful in the valuation of innovative undertakings, especially high-tech ones. The method is consistent with the stage-gate process approach. The authors of this method have specified ten phases and levels of the valuation of an undertaking from the perspective of its readiness for deployment. It could be said that the outputs of a research project can be commercialised after each positive valuation of any development stage, hence the need may arise to carry out the valuation of these outputs after each of the phases. The basic valuation phases encompass:

- the concept phase – the testing of the appropriateness of a solution concept by analytical and experimental means (technical assessment),
- the prototype phase – the verification of the way in which basic elements and components of the model function under laboratory conditions (technical assessment),
- the verification phase – the verification of the way in which the product prototype functions in the target operating conditions (technical assessment),
- the transfer phase – the preparation of the product for production and sale on a commercial basis (technical, organisational and economic assessment).

The process of designing a technology transfer project based on the valuation of commercial potential can also be carried out in three phases: (i) the initial valuation, (ii) the in-depth valuation and (iii) the final valuation conducted on the basis of the indicators set out in the business plan of the undertaking.

Theoretical foundations in this area were described by Jolly, who proposed an innovative model of technology commercialisation [10]. Its fundamental message points to a non-linear, though staged, process of commercialisation. At the same time, the pattern of documents created displays the aforementioned three-phase format. It should be emphasised that individual stages overlap to a certain extent and the outputs achieved at the previous stages are verified and used to create further documents. Jolly's concept is a comprehensive approach to the process of technology transfer and technology commercialisation that encompasses the process of project design and development, as well as the process of its valuation. The process of analysis can be taken into account only in a selective and schematic way to create a valuation system. It is assumed that only specified effects of the analysis such as the adopted business model, product specification and financial construction, are valued.

Jolly's concept refers to the approach called *Quicklook* and *Indepth* created at Texas University. It is acknowledged and used in many countries. Research and industrial institutions, particularly micro, small and medium enterprises, use this type of tool successfully in valuation of market potential and possibilities of commercialising

new undertakings (technologies or products). In this manner, they shape the process of commercialisation, which starts at the moment when an idea for a new technology or product is born and finishes when a licence is sold or a solution is launched onto the market [15]. The initial and in-depth valuation conducted concerns:

- the strategic criteria,
- the potential for direct benefits,
- the market potential and barriers to market entry,
- the technology,
- the degree of identification of end consumers,
- the determinants connected with the protection of intellectual property,
- the technical condition,
- the necessary resources (expenditure).

The staged valuation process of innovative projects has its advantages and disadvantages. It is relatively simple and transparent, which allows its widespread use. It enables rejecting less profitable concepts step by step until only the most promising ones are left, which limits the losses of a research institution or enterprise when significant project defects (market or technical) are found, as there is the possibility of stopping its realisation at a relatively early stage.

On the other hand, a detailed analysis and project valuation can be costly and absorbing (expert valuations, market research, etc.), particularly for smaller entities ([2], p. 135). Another drawback of the stage-gate approach is the possibility of manipulation, i.e. modification of the assumptions used by the valuation team such that an “ailing” project meets the expectations of the institution’s management. The managers that supervise the realisation of the project, in particular its individual stage-gates, may face difficulties in the assessment of the importance of the assumptions and the verification of their feasibility. This approach also assumes that the proposed strategy is correct, which is very difficult to establish in the case of innovations that create new markets – the correct strategy needs to emerge by itself and then be verified [3].

### **3. Problems connected with measuring the potential of an innovative undertaking in order to carry out its valuation**

Measurement and valuation are not identical concepts. Measurement is a wider concept and means the choice of an indicator for a particular object. This indicator can be a natural unit, a conventional unit or even a value (currency). Valuation, on the other hand, aims to establish a theoretical value, “a value in itself”. Measurement of

the innovation potential of the outputs of an innovative project can have a much wider application than preparing the foundations for its valuation.

There are many reasons for such measurements. These include ([16], p. 91–92):

- necessity for project accounting,
- streamlining the transfer process,
- demonstration of project value,
- analysis of the probability of the project's success based on the valuation of the project's potential just before making the decision on its realisation.

The process of measuring innovation potential, however, is essential if the transfer of the output of a research project is to be carried out by commercial means. This refers not only to the case of the sale of research outputs in a specific form (e.g. a licence), but also in the form of an in-kind contribution when these outputs take the form of a contribution to innovation potential in exchange for company shares.

Measurement can be carried out either by the seller or the purchaser of these outputs. The seller is interested above all in the reimbursement of the expenses incurred during project implementation, while the purchaser is mostly interested in the potential that influences their operational, non-material and legal assets (e.g. a production licence) or intellectual assets that serve to advance research activity, since the purchaser aims to present innovation potential in the form of assets listed on the balance sheet.

#### **4. Practical aspects of the valuation of innovation potential**

Innovation potential constitutes one of the elements of intellectual assets. It is possible to accept a very wide definition of innovation which suggests that organisational and market assets fall under the concept of innovative assets, as they encompass organisational, product and technological innovations. However, it seems more correct to accept that the value carrier is an important criterion of an asset. The carriers for particular outputs of an innovative project are so dissimilar that it is justifiable to distinguish innovative assets as a separate component of intellectual assets. The methodology of measuring innovation potential presented below is the result of the studies of four cases of in-kind contribution to a company of so called know-how, which is the output of research projects carried out by their sellers. For the seller, the contribution from this know-how is the sale of the outputs from a research project. For the purchaser, the contribution is the established innovation potential and, the sale is the source of acquiring this potential. In each case analysed, the outputs from innovation were not listed on the balance sheet of the owner. Each time, the process of making the in-kind contribution to the company in the form of outputs from innovation was carried out in three phases:

1. Their identification was carried out, which served to determine the so called capacity for contribution to know-how (a description of the outcomes of the potential application of an innovation).

2. Measurement was carried out to assess the outcomes resulting from the application of the outputs in the company purchasing them.

3. Their valuation was carried out.

The problem of the capacity of know-how to contribute as a carrier of innovation potential aroused a lot of controversy at the beginning of the 1990's, although it is hard to argue against the thesis that the creation of know-how requires expenditure and that the purchaser of know-how gains notable benefits. The controversy concerning the capacity of in-kind contribution from innovative assets was the subject of many court decisions. The concept of the capacity of know-how to contribute was approved by the Voivodeship Court in Warsaw in the ruling of 2<sup>nd</sup> July 1990. Capacity for in-kind contribution is attributed to the technical secrets, as well as confidential trade and organisational information, held by a company.

Far less controversy surrounds know-how valuation if the whole company is the object of in-kind contribution, not a separate element in the form of know-how. However, separate know-how can also be the object of in-kind contribution provided certain conditions are met, since difficulties are caused by the function of in-kind contribution as a factor determining the equity declared and the function of basic capital. Taking into consideration these functions, the following criteria of the capacity for in-kind contribution of any asset, i.e. the innovation potential contained in know-how, should be adopted:

- it should demonstrate the capacity of transferring ownership to a business entity,
- it should have a notable balance-sheet value as an enterprise component of an asset acquiring entity,
- it should enable debt collection, in order to satisfy creditors' claims.

These criteria constitute a significant challenge for valuating the capacity for in-kind contribution of the innovation potential present in the outputs from research projects, particularly when these outputs are the result of early development phases. They also offer guidance for all parties as to what the process of this type of in-kind contribution should look like.

First of all, the fact of making an in-kind contribution to a company in the form of output from research projects ought to be documented in clear terms to prove that the transfer of ownership took place (the identification phase). There could be problems, especially in the case of confidential information regarding the output in the form of, for example, technical secrets. This information should be precisely detailed in a confidential document to enable its identification.

The measurement and valuation of innovation potential should be carried out thoroughly pointing out its application, as well as its capacity to participate in business trading (the capacity to commercialise the output of research projects). In the case of

a joint stock company, there arises the necessity to verify the value of in-kind contribution by chartered auditors. In-kind contribution in the form of the output of research projects should also have a sale value that determines its capacity to cover debts in case the company becomes insolvent and needs to declare bankruptcy.

## **5. An outline of the methodology for valuating innovative projects as an in-kind contribution**

Innovative projects are carried out in various legal and organisational structures. It is a rare occurrence for all the phases to be carried out within the framework of one entity. The outputs of individual phases can be transferred to other entities and in-kind contributions to commercial companies may be one of the forms of such transfer. The approach to the valuation of innovative projects can differ depending on the methodology of valuation. The effective valuation of innovative projects is subject to initial and in-depth valuation ([16], p. 123).

In order to confirm the capacity for in-kind contribution of the output of innovative undertakings, the evaluation results presented should contain conclusions that refer to:

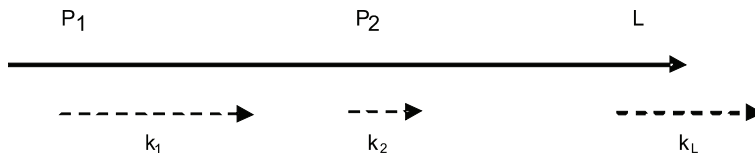
- the degree of maturity in implementation,
- the subsequent development stages of the project outputs,
- the duration of subsequent phases.

The methodologies presented in the literature that measure the outputs of innovative projects generally offer a rather extended system of indicators [8], ([16], p. 93–120). Effective valuation depends on the possibilities of finding synthetic indicators that convey the essence of the benefits derived from the implementation of outputs from innovative undertakings. For example, the “period ahead of the competition” (PAC) which determines the degree of competitive advantage achieved by the entity implementing the transferred technologies can be such a synthetic indicator ([12, p. 18–19], [14]. It can be defined as the length of the period until the innovation becomes disseminated to the extent that every company can initiate production based on that technology without the necessity to purchase the rights for it. This period of innovation dissemination cannot be longer than the period of the economic depreciation of the value of outputs from innovation.

The observation of the cases of in-kind contribution of innovation outputs confirmed that the determination of such an indicator is possible. Valuation teams that value innovative projects can be assigned the task of PAC determination. In the cases analysed, the outputs of an innovative undertaking were the ideas, formulas and models of the output that constituted the innovation and allowed the company acquir-



ing them in the form of in-kind contribution to achieve a competitive advantage within, e.g. 5 years, 3 years, 2 years, etc. The estimation of the period ahead of the competition was carried out with the intention of transferring the outputs in the form of in-kind contribution to commercial companies. The positive completion of the work undertaken for the purposes of valuation leads to an important conclusion that the period ahead of the competition can be a synthetic indicator to value an innovation. This period can be estimated by innovation experts based on analysis of the market, competition and the degree of innovation. There are no reasons to believe that there is more subjectivity in such a valuation than in any other methods of measuring innovation potential.



**Fig. 2.** Changes in the competitive position of companies according to “period ahead” in the process of measuring innovative assets: P<sub>1</sub>, P<sub>2</sub> L – competitive companies, L – leader, k<sub>1</sub>, k<sub>2</sub>, k<sub>L</sub> – innovative progress in each company. Source: Authors’ compilation

It can be said that the measurement of innovation potential over the periods when a competitive advantage lasts is possible for each company, even for an outsider (e.g. k<sub>1</sub>). The value of the outputs of innovation, however, has a relative character and is positive when the innovation shortens the distance to the leader (k<sub>1</sub> > k<sub>L</sub>) and, in the case of the leader, when the “ahead” period over the competitors is lengthened due to innovation (see Fig. 2). In our opinion, it would be difficult to talk about a negative innovation value. If, despite innovative activity, the distance between the company P<sub>2</sub> and the leader L has grown, there has been no innovation in P<sub>2</sub> or its value equals zero. It should be emphasised that the measurement of innovation potential is seen as a precondition for carrying out its valuation by means of the method presented here. This measurement can be carried out within the framework of the aforementioned methods for evaluating technology transfer or with the use of methodology that evaluates the degree of maturity in the implementation of technical innovations (DIM).

After conducting the measurement of the period ahead of the competition, each output from innovation can be valued with the aid of the modified method of discounted cash flows (DCF), assuming that their value  $V$  equals the difference between the total sum of the discounted cash flows generated by the company (not only their innovation-induced growth) over the  $n$  periods starting at the moment  $t_0$  (the moment of the acquisition or creation of innovative assets) and the sum of the same discounted cash flows over the  $n$  periods starting from moment  $t_0 + k$  where  $k$  denotes the period ahead, i.e. the period for which competitive advantage lasts due to the assets from innovation:

$$V = \sum_{t=0}^n CF_t - \sum_{t=0+k}^{n+k} CF_t$$

In one of the analysed cases, the object of in-kind contribution was the output from innovation created as a result of research activity carried out for three years on the construction of the cab of an “air taxi” – a four-person airplane. This research was conducted by an individual running a registered business and was financed, among other things, by public funds. The continuation of this research required more funding. In order to raise funds, a limited joint-stock partnership was formed with the general partner’s in-kind contribution in the form of the existing outputs of the research project and the limited partner’s in-kind contribution in the form of the financial resources for completing the research. The accounting assets of the individual’s company also referred to business activity that was conducted outside the scope of the “air taxi” project, hence they could not be used as a basis for the valuation of in-kind contribution.

The outputs of the completed part of the research project were defined as:

- the documented proprietary technology of plane geometry construction and mould manufacturing for the production of composite airplanes,
- the proprietary construction and technological solutions applied in the construction of composite airplanes.

The essence of the technological value was the possibility of constructing the airplane – the “air taxi” – designed for professional purposes with the following features important for the user:

- great accessibility, confirmed by users during trial flights,
- the ease of getting into the airplane,
- the spacious interior that allows the transport of approximately 20% more luggage than the interior of the airplanes currently manufactured.

The value of the in-kind contribution in the form of the above mentioned innovation outputs enabling further work on the construction of the cab for the air taxi was estimated based on the assumption that the basic indicator of the effects of implementation is the possibility of starting the production and sale of airplanes 2 years ahead of the competition (after taking into consideration the estimated period needed for the continuation of further research and deployment). Thus, the estimated value of acquiring these outputs by the company was determined as the difference between the sum of the discounted 5-year revenue from the sales of the airplanes calculated under the assumption that the revenue will appear directly after the in-kind contribution is made and the sum of the discounted 5-year revenue based on the assumption that revenue will start to appear 2 years after investment completion, i.e. after the innovation is disseminated so much that the production will not need the purchase of a licence. It was assumed that the innovation has no influence on the residual value of the com-

pany, since its value is depreciated over the period ahead of the competition. Thus, the residual value was omitted in the valuation of the in-kind contribution (see Table 1).

**Table 1.** Example of the valuation of outputs from innovation transferred in the form of in-kind contribution

| Quantity   | Period |        |        |        |        |        |        |       |
|--|--------|--------|--------|--------|--------|--------|--------|-------|
|  | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7     |
| Time ahead of the competition, year  | 2      |        |        |        |        |        |        |       |
| Discounted values, thousands of PLN<br>after the in-kind contribution of outputs<br>from innovation            |        | 1279.6 | 1219.7 | 1162.6 | 1108.2 | 1056.4 |        |       |
| without the in-kind contribution of outputs<br>from innovation   |        |        |        | 1162.6 | 1108.2 | 1056.4 | 1006.9 | 959.8 |
| Sum of the discounted values, thousands of PLN<br>after the in-kind contribution of outputs<br>from innovation | 5826.6 |        |        |        |        |        |        |       |
| without the in-kind contribution of outputs<br>from innovation   | 5294.0 |        |        |        |        |        |        |       |
| Acquisition of the outputs from innovation,<br>thousands of PLN)   | 532.6  |        |        |        |        |        |        |       |

Source: [9], p. 123–133.

A similar method for the valuation of outputs from innovation was applied in the three other cases analysed. There were differences in the estimated periods of competitive advantage achieved due to the acquisition of the innovation and the size of the discounted cash flows generated by the company.

## 6. Summary

In general, it can be assumed that one of the methods of measuring the potential present in outputs from innovation can be based on the duration of the competitive advantage resulting from their application. This indicator can be used widely: both as an indicator for the leader staying „ahead” of the competition and for a company that has decreased its distance from the leader due to innovative assets it has acquired or created.

The simplified valuation of innovation potential is based on the adoption of the following assumptions:

- The acquisition of innovations in the form of in-kind contribution enables the achievement of the same cash flows as the exploitation of the output after its general dissemination.

- The value of outputs from innovation does not influence the residual value of a company, since their potential is exhausted after  $k$  periods – their value is depreciated.

Despite the fact that the analysed cases – used to establish the method presented above – concerned the in-kind contribution of outputs from innovation (the technology transfer phase), they allow us to draw the conclusion that this method can also be applied to carry out the valuation of the outputs from innovation when these outputs are transferred to the next development stage within the same research entity.

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